ANNUAL REPORT 1976

AQUACULTURE DEPARTMENT

SOUTHEAST ASIAN FISHERIES
DEVELOPMENT CENTER
TIGBAUAN, ILOILO, PHILIPPINES

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COVER

Developing countries are turning away from their overcrowded lands and are looking forward to their inland waters and deep seas to provide them with richer food for their teeming populations through aquaculture.

Once merely the art of growing fish for food and aesthetic pleasure, aquaculture with a rich, 3,500-year history behind it has recently evolved into the science of harnessing the resources of the seas and inland waters.

One of the world's major aquaculture centers is the Southeast Asian Fisheries Development Center Aquaculture Department in the province of Iloilo, the Republic of the Philippines.

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OVERVIEW

Over the past year, we developed our capabilities at a much faster pace following an encouraging breakthrough in prawn culture, diversification of our research activity, an increase in manpower and the development of more linkages.

About seventy-five (75) per cent of the infrastructures that we planned to build in 1975 have already been set up. For the coming year, we plan to grow further by establishing another facility — a seafarming station at Zamboanga City.

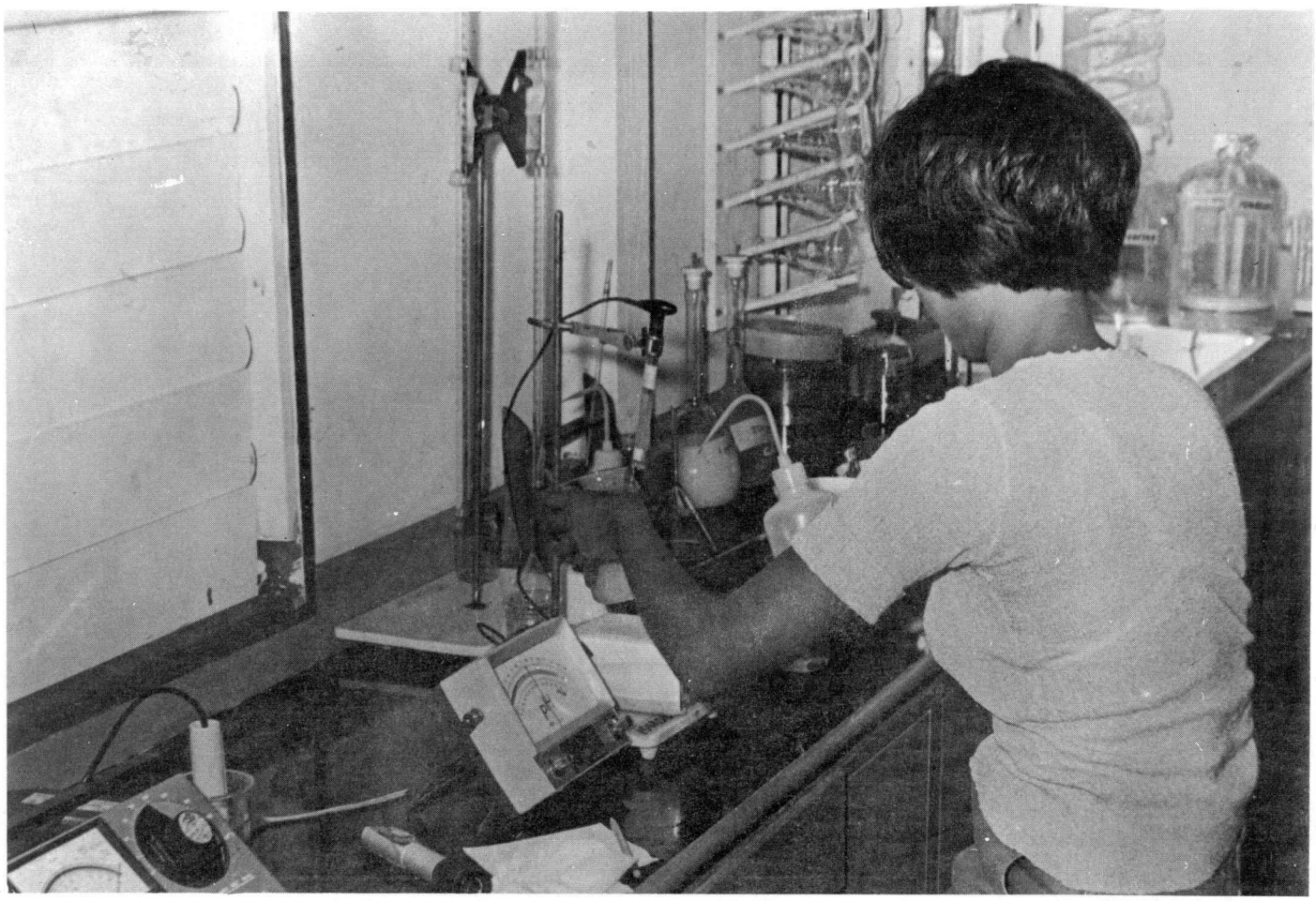
Perhaps the most significant development was the completion by our scientists and technicians of the life cycle of the prawn, *Penaeus monodon* (sugpo) in captivity, followed by the increase in survival rate of sugpo fry in the hatchery. We were also able to gain valuable knowledge on spawning of milkfish and moved into diversified but related studies on seafarming as well as fresh-water aquaculture.

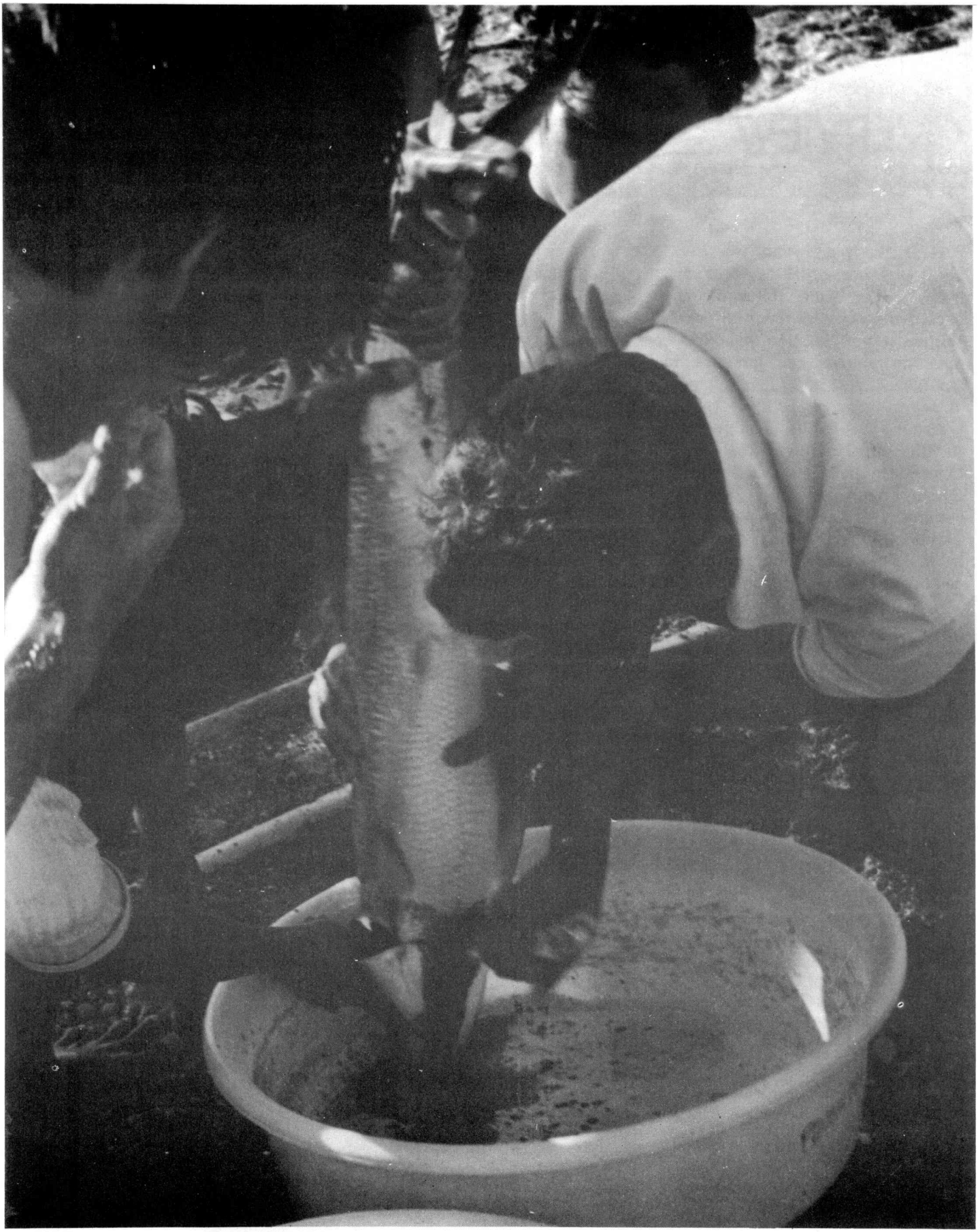
At the same time, we conducted more training programs for research workers, technicians and fish farmers. These included formal long-term as well as special short-term training schemes.

We enlarged our research and administrative working force to tackle the growing volume of projects. Hand in hand, we reorganized the Department in order to foster greater coordination and control of work which is spread over many places. To give our staff better motivation for quality work, we set up a scheme of promotions together with a program of scholarships. This was coupled with the establishment of a provident trust fund for employees.

We expanded our library by the purchase of more books and subscription to a greater number of journals as the library moved to a new building.

Finally, we strengthened formal linkages with old as well as new international and local institutions.





Preparation for stripping sabalo female
for artificial fertilization of eggs.

RESEARCH

Our four major programs — milkfish, prawn, seafarming and freshwater fisheries cover these areas of research: a) production of quality seedlings of desired species; b) increased production through improved pond design, construction and management; c) improvement of natural foods; d) control of diseases, parasites and predators; e) prevention and control of pollution affecting aquaculture operations; and f) nutrition studies and feed development.

The Department maintains six research stations: a) Tigbauan Main Station for both prawn and seafarming programs; b) Leganes Station for prawn and milkfish programs; c) Pandan Station for milkfish program (spawning); d) Igang Station for the prawn, milkfish and seafarming programs; e) Binangonan Station for the freshwater fisheries program; and f) Zamboanga Station for seafarming program.

We put up research laboratories to provide these stations with appropriate facilities and enable researchers to undertake priority studies.

Supporting substations have been established especially for spawner collection and fry distribution studies.

MILKFISH PROGRAM

Research Highlights for 1976

The milkfish studies in Pandan, Antique seek to develop a suitable technology for mass production of milkfish fry. We collect milkfish spawners (sabalo) from the wild to induce them to spawn in captivity. The sabalo, a highly excitable fish, jumps and tends to injure itself when captured and transported — a problem that we have overcome by evolving a technique for proper handling and transport.

Our experiments in spawning have achieved partial success — administration of the hormone SG-G100 (Salmon gonadotropin) induced females to ovulate although their eggs were not fertilized due to the absence of ripe males. Because of this, we are doing experiments on the cryogenic preservation of the milt.

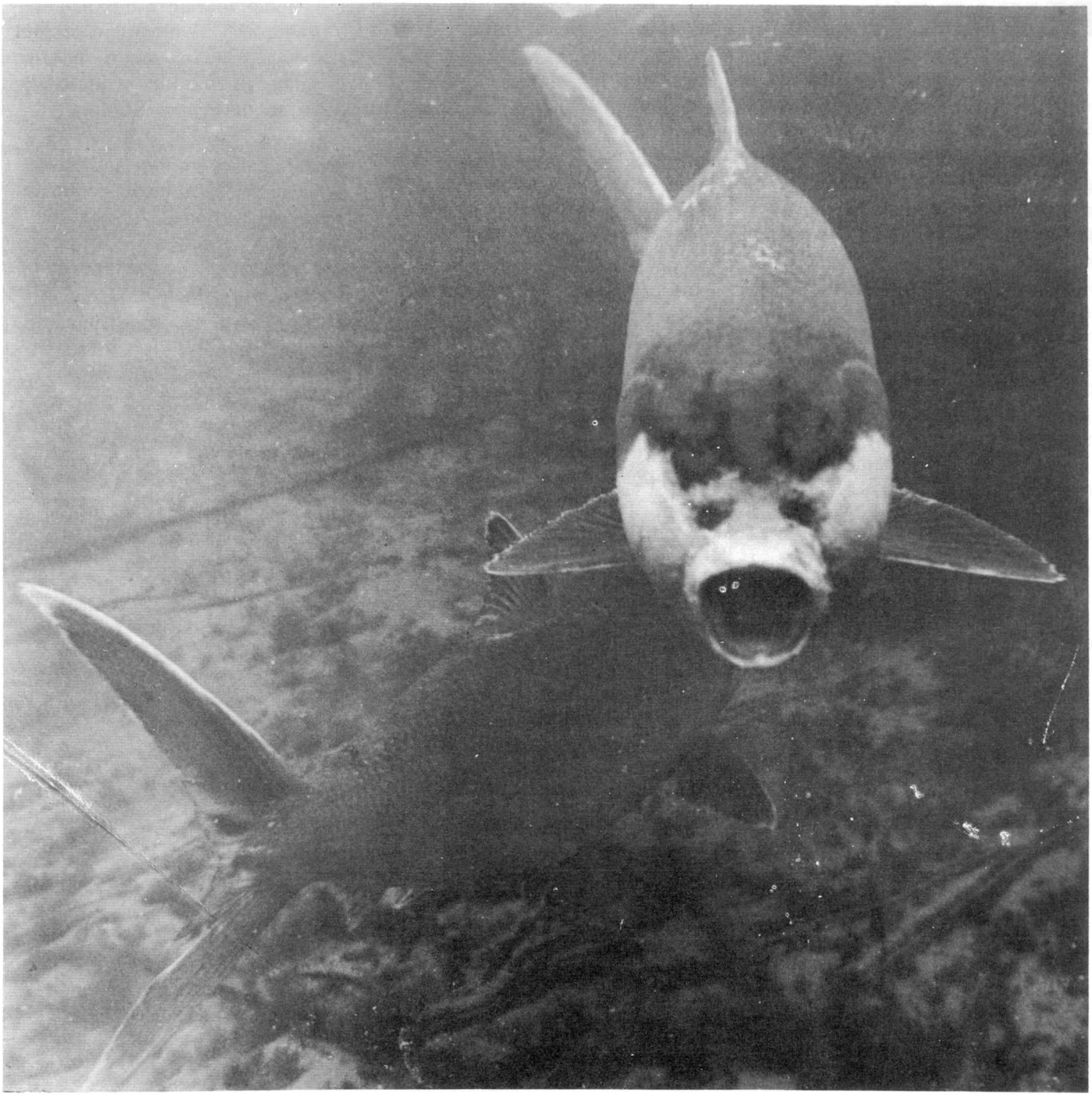
Sex differentiation studies of the sabalo through examination of the external morphology are being conducted.

A broodstock of wild sabalo is being domesticated and reared at the Pandan Station. Simultaneously, a broodstock development project for pond-grown juvenile milkfish is being carried out in maturation pens at the Igang Station.

Egg and larval surveys have provided interesting and basic data on the location of probable spawning grounds, nature of the eggs, incubation period and characteristics of newly-hatched milkfish larvae.

The systematic collection and study of milkfish fry from Hamtik and Pandan waters indicate two spawning seasons, in contrast to a single peak season for other regions of the Philippines. This suggests the possible existence of races or subpopulations of milkfish (bangos). We conducted studies on the differentiation of subpopulations through the vertebral count of fry which are progeny of spawning adults caught after they return

Obtaining sabalo egg samples through a catheter



Domesticated sabalo inside canvas tank

near the shore following an undetermined period in the open sea. To localize spawning areas, we conducted ultrasonic tagging experiments with the aid of Canadian scientists to track the movements of the sabalo in coastal waters.

Our experiments on the polyculture of bangos with prawn (sugpo) show that bangos grow better with prawns at the ration of 25 sugpo to one bangos compared to other stocking rates.

Capture, Transport and Domestication

During the 1976 spawning season, sabalo caught by gill net, fish corral and otoshi-ami were transported to experimental tanks, hatchery tanks and fishpens at Pandan, Tigbauan and Igang.

A total of 259 sabalo caught at Hamtik and Pandan were transported to station laboratories. It called for transfer of the fish from the otoshi-ami to a transport cage made of PVC and nylon, then to shore in a pumpboat and finally, to a 1.5-meter long plastic bag. Bangos from Pandan waters were transferred directly from the plastic bag to experimental tanks, while those caught in Hamtik were released into a holding tank on a waterproof canvas tank on a pick-up for land transport.

Of the 259 bangos transported, 49 or 19% died of injuries sustained during capture and transport (Table 1). Three of the survivors were used in our tracking and tagging experiments.

We used a different method of transport in a parallel set of studies which resulted in a 97% average survival rate from a total of 33 sabalo (Table 2). In this method, sabalo caught by gill nets, fish corrals and otoshi-ami were placed in an inverted position inside a wooden tank and brought to shore. They were then transferred to a trough made of nylon frame, lined with urethane foam, while the bangos were still in the inverted position (Figure 1). Two to four troughs were installed inside a one-ton PVC tank aerated and cooled to 20°C.

It has been commonly observed that captured sabalo generally have opaque eyelids indicating a state of stress. Recuperation of the fish and return to the original transparency of the eyelids take place only after a week. Those that do not recover from stress eventually become blind and die. Fish placed in a lagoon at the Pandan station died most probably due to high salinity and confirmed earlier observations on the need to place adults in brakishwater to enable them to survive the first ten to twenty days of captivity.

Spawning of Milkfish in Captivity

Sixteen sabalo (13 mature and 3 immature) were injected with SG-G100. On two occasions hydrated eggs (Figure 2) were released by two females. However, the eggs were not fertilized because none of the males released sperms, one male with freely flowing milt having injured itself and subsequently died (Table 3).

The whole procedure involved putting the sabalo in tanks with lower salinity (20-25 ppt), injecting 1-3 ml of gonadotropin into the masculature below the dorsal fin, and increasing salinity back to 34 ppt.

Broodstock Development

A total of 893 bangos juveniles were stocked in two maturation pens in Igang for three months. Raised from wild fry in the Leganes ponds for six months, the fishes were transported by motorized banca with an average survival rate of 79%.

Table 1. Survival of sabalo during transport (A polyethylene bag was used during transfer from one tank to another)

	No. of Fish		
	Number Died	Released or still alive in tanks	Experimental fish transferred to lagoon
Died during capture	18	—	—
Released to sea immediately after capture	—	100	—
Died during transport in truck	9	—	—
Badly injured during capture and cage transport	22	12	—
Domestication experiments - tanks	1	13	21
Domestication experiments - lagoon	10	—	34
Spawning experiments	6	4	6
Domesticated fish released to sea by tagging team	—	3	—
T o t a l	66	132	61

Table 2. Survival of sabalo during transport (Fish restrained in an inverted position in a trough lined with urethane foam)

Date	Source and destination	Number trans-ported	Number died in transport	% Survival	Travel time (hr)	Means of Transport
May 1976	Otoshi-ami, Pandan to Tigbauan hatchery	13	1	92	5	Motor vehicle
April and May 1976	Fish Corral Tigbauan to Igang Station	4	0	100	1	Boat
April and May 1976	Gill net, Lusaran to Igang Station	3	0	100	1	Boat
May 1976	Fish corral, Tigbauan to Tigbauan hatchery	12	0	100	5 min.	—
	T o t a l	32	1	97		

Fig. 1. Sabalo in inverted position on Double "M" Metal Frame

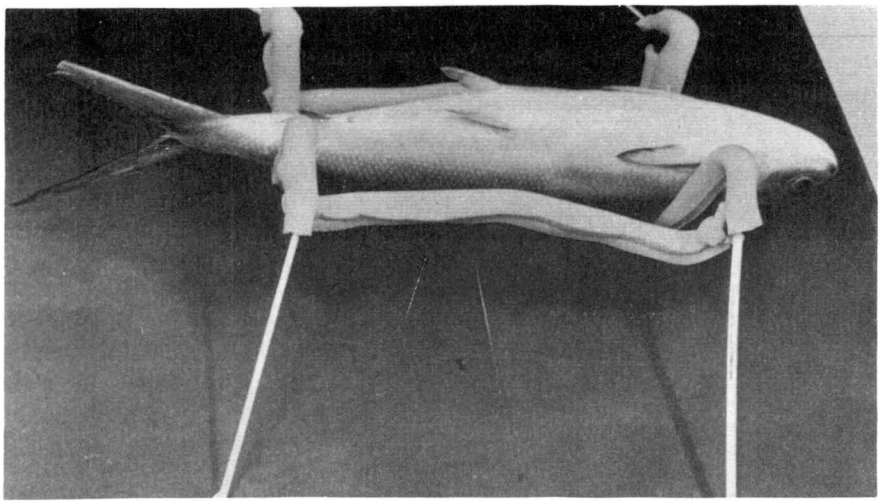
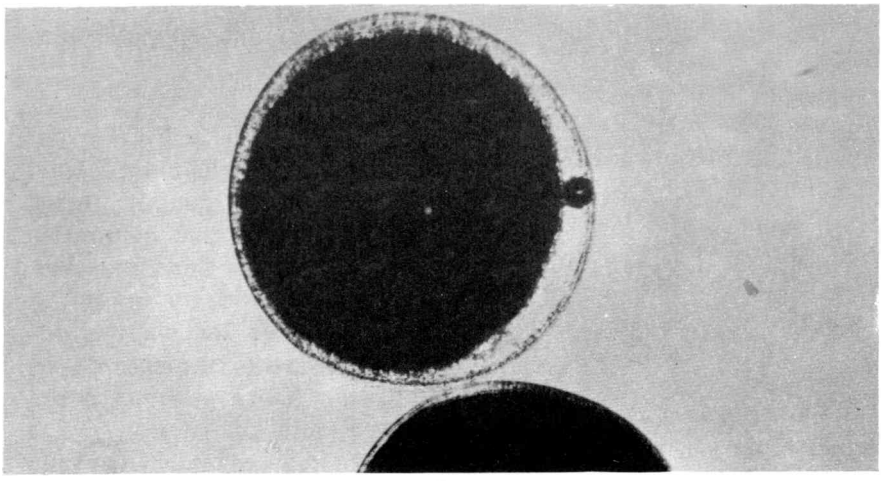


Fig. 2. Hydrated milkfish eggs



Growth rates for one year are shown in Figure 3. Two types of feeds were used: a) fine or coarse rice bran (tiki-tiki and darak) and 2) commercial fish pellets. The fish are gradually being domesticated — they can be fed by hand, having learned to associate feeding time with the striking of two bamboo sticks.

Cryogenic Preservation of Milkfish Milt

Difficulty in synchronizing the maturation and gonadal release of male and female milkfish made it necessary to try cryogenic preservation of milt, for immediate use when a female milkfish spawns. Facilities for holding liquid nitrogen and refrigeration of frozen milt have been assembled. Two staff members were sent to Bangkok, Thailand to study cryogenic preservation technology.

Milkfish Ecological Survey

We concentrated initial efforts on the tentative identification of milkfish eggs using a provisional identification key based on the available literature.

It was found that a distinguishing feature of the milkfish egg is the lack of oil globules. Other major fish species have eggs with one or more oil globules. Yolk transparency in formalin makes it possible to separate milkfish eggs from those of other species with only one oil globule.

Plankton tows around Panay waters showed the occurrence of milkfish eggs from the surface down to 20 meters (Table 4). Table 5 shows the high variability in egg and larval catch from day to day. It suggests daily fluctuations in the spawning activity of milkfish.

Milkfish eggs are relatively rare. Out of a total of 10,531 fish eggs collected during the trip, only 35 or 0.33% were milkfish eggs.

Number of Vertebrae in Milkfish

Many scientists believe in the possible existence of races and/or subpopulations of milkfish, a widely distributed species. One useful method of identifying subpopulations is by comparing the mean number of vertebrae.

Studies were made to examine the progress of ossification in the vertebrae of different sizes of milkfish larvae collected near Tigbauan and Hamtik stations. The larvae were stained with alizarin red.

Majority of the specimens had either 43 or 44 vertebrae (Table 6). The highest mean vertebral count was 43.447 as observed in Tigbauan specimens and the lowest mean value was 43.427 for Hamtik specimens. These results were compared with specimens collected from Taiwan and other countries (Table 7).

Ultrasonic Tagging and Tracking

Four bangos were tagged and tracked for 2.3 hours (Track 01), 3.8 hrs. (Track 02), 1.0 hr (Track 03), and 24.0 hrs. (Track 04) over a total distance of 31 km in April 1976. The sabalo used in Tracks 01, 02, and 03 (probably all males) were tagged with 74 kHz transmitters while the sabalo for Track 04 was double-tagged with 74 and 50 kHz tags. The transmitters were attached to the base of the anal fin.

Swimming speed during the first hour after release was about 2 kph. Average speed thereafter varied from 1 to 2 kph with maximum speed up to about 6 kph for short periods (30 minutes). Fish used in Track 04 slowed down and stayed in one position for long periods up to 6 hrs. (Figures 4, 5, 6 and 7).

Salinity Preference of Milkfish

Vertical salinity gradient columns were used to investigate the salinity preference of milkfish fry. Fry placed in the experimental tanks with stratified salinity ranging from 12 to 32 ppt or control tanks with uniform salinity of 32 ppt immediately swam to the bottom where they appeared disoriented. After one hour, the fry recovered from handling stress and swam freely up and down the column of water in the control tank but remained in the 32 ppt layer in the experimental tank. Fry maintained in water with salinities of 12 and 22 ppt for 1 to 5 days did not exhibit a preference for any particular salinity but swam at random in the control and experimental tanks. It was also observed that acclimatized fry

Table 3. Spawning data of sabalo (After injection with SG-G100)

Expt. No.	Female		Male		
	Stage III	Spawned		Sexually immature	Total
1	2*	1* 1**	1	3**	8
2		1*	2		3
3	1++		4		5
Total	3	3	7	3	16

* Died, gonads examined

** Released to domestication tank

\+ Injured itself and subsequently died; with freely flowing milt

++ Killed for gonadal examination.

Table 4. Occurrence of milkfish eggs around Panay Island

Location	Date (1976)	Depth	Total Number	Tows w / eggs	Number of eggs collected
Pandan Bay	Apr. 4	0	2	0	0
		5	2	0	0
		10	1	1	1
		15	1	0	0
		20	1	0	0
	May 5	0	3	0	0
		5	0	1	2
Batbatan Is.	Apr. 4	0	2	2	11
		5	2	1	5
		10	0	1	5
		15	1	1	10
		20	1	1	9
	May 4-6	0	6	5	38
		5	7	3	11
		10	1	0	0
		15	2	1	1
		20	2	1	1

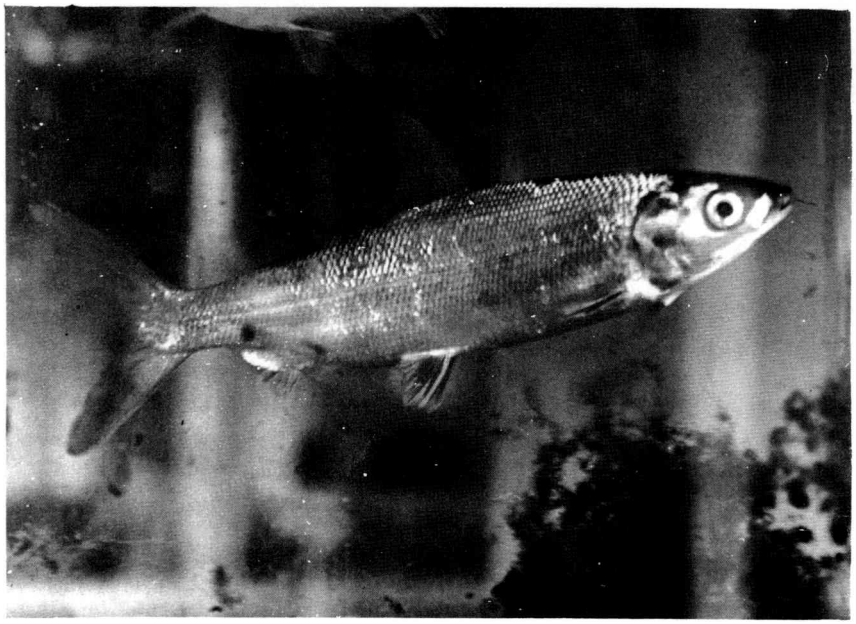


Fig. 3. Average growth rate of bangos in maturation pens

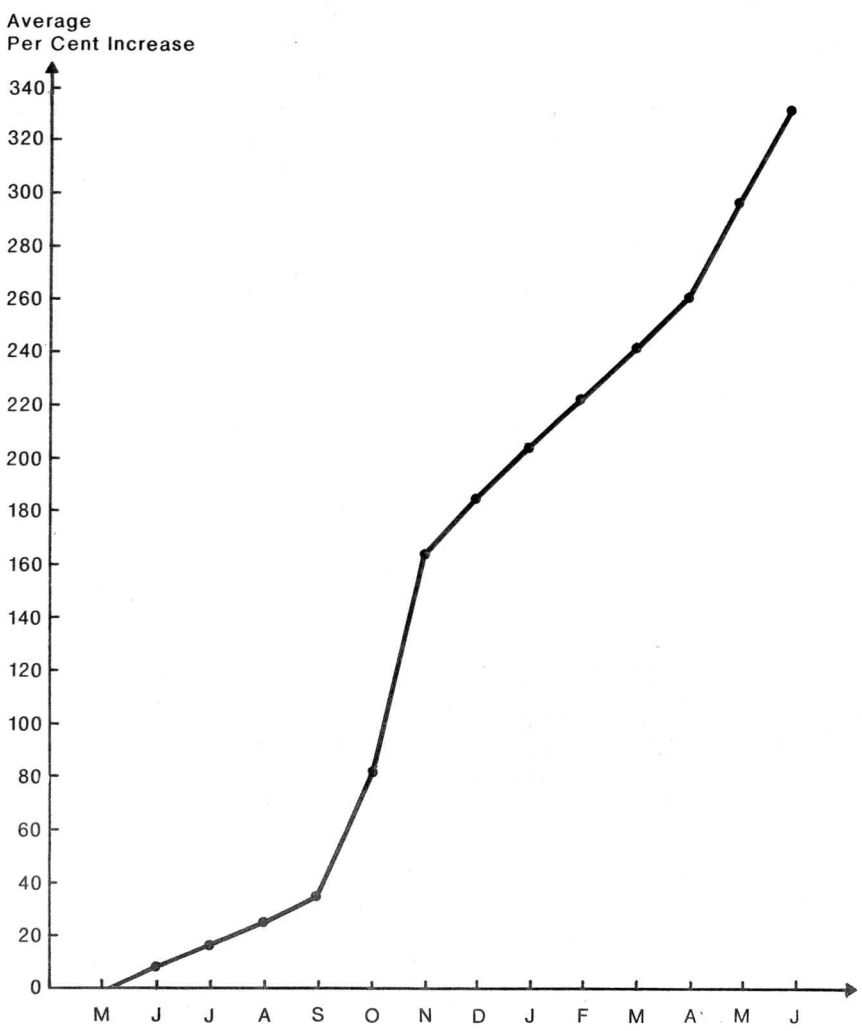


Table 5. Milkfish eggs collected around Batbatan Island

Date	Number of tows	Number of eggs collected
4 April 1976	6	33
4 May 1976	6	0
5 May 1976	8	42
6 May 1976	4	9
Total	24	84

Developmental stages of eggs by time of collection:

Time of collection (Hours)	Developmental stage*		
	Aa — Ac	Bb	Ca
0800 — 1000	2	1	
1000 — 1200	1	38	
1200 — 1400			
1400 — 1600			23
1600 — 1800		19	19
Total	3	39	42

*Aa — Ac: Early stages of development up to yolk invasion half compieted.

Bb Embryonic streak reaches its maximum length on the yolk; but its posterior end is flat. (In Bc, the posterior end of the embryo is vertical to the surface of yolk).

Cc The tip of the tail of the embryo is free from the yolk, but not quite elongated.

Table 6. Number of vertebra in milkfish fry

Number of Vertebrae	Collecting Stations		
	Tigbauan	Hamtik	Taiwan
40	—	1	—
41	—	4	—
42	2	3	2
43	100	145	19
44	86	119	20
54	—	7	—
Total number of specimens	188	279	41
Mean vertebral number	43.4270	43.4270	43.4390
Variance	0.2684	0.4465	0.3525
Standard deviation	0.5181	0.6682	0.5937
Standard error	0.0378	0.0400	0.0927

Table 7. Number of vertebra in milkfish (Reported from different localities by various authors)

Locality	Author	Number of Vertebrae
India	Gunther, 1868	44
Indonesia	Sunier, 1922	44 - 45
Indonesia	Delsman, 1923	43
Philippines	Herre & Mendoza, 1929	46
Hawaii	Jordan & Evermann, 1905	45

Fig. 4. Track 01 12 April 1976

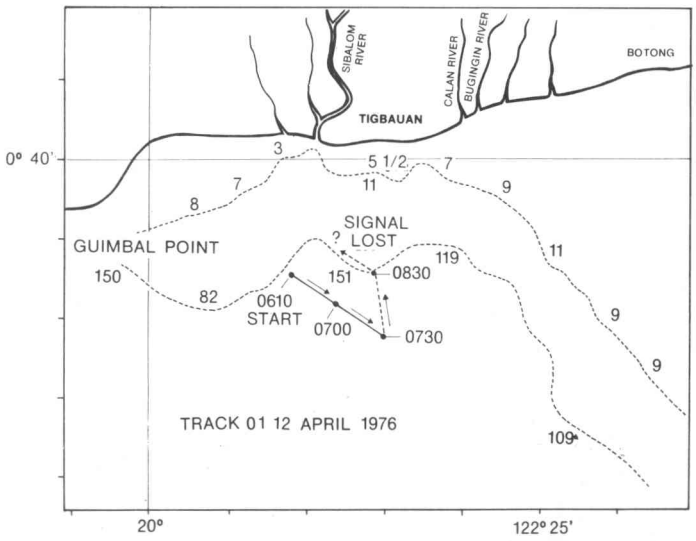


Fig. 5. Track 02 18 April 1976

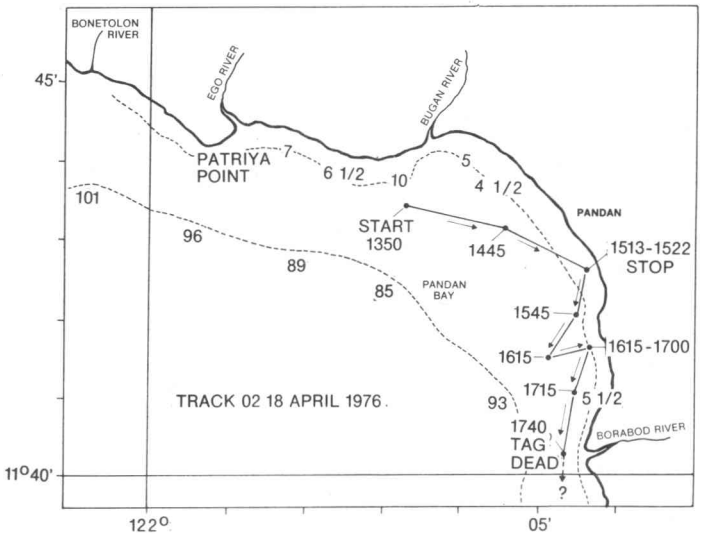


Fig. 6. Track 03 19 April 1976

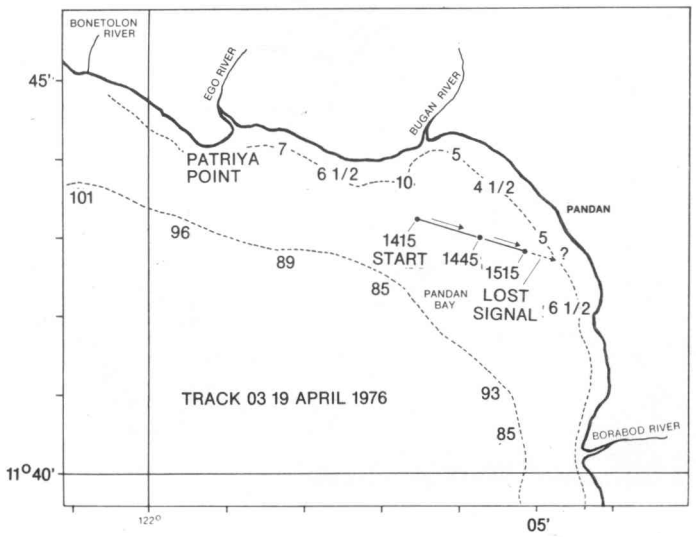
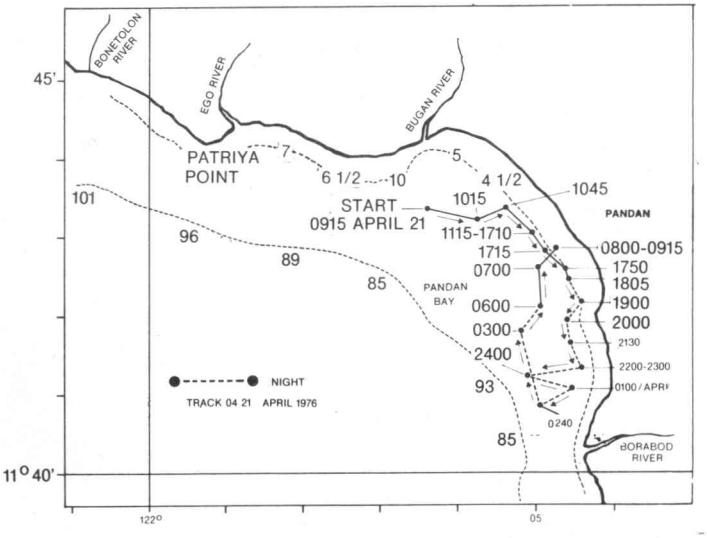


Fig. 7. Track 04 21 April 1976



tended to stay longer at the bottom of each tank and appeared to be nibbling or searching for food particles.

Seed Bank

Fry occurrence is seasonal. In order to assure a steady yearlong supply, stocking and stunting techniques were studied. Stunting required a high stocking density but there were more problems associated with predators.

Since the predators were observed to grow at a much faster rate, we sorted them out with periodic and progressive sieving using various sizes of meshed screens. The survival rates of milkfish fry improved from 15% to 50%.

Pond Cultivation

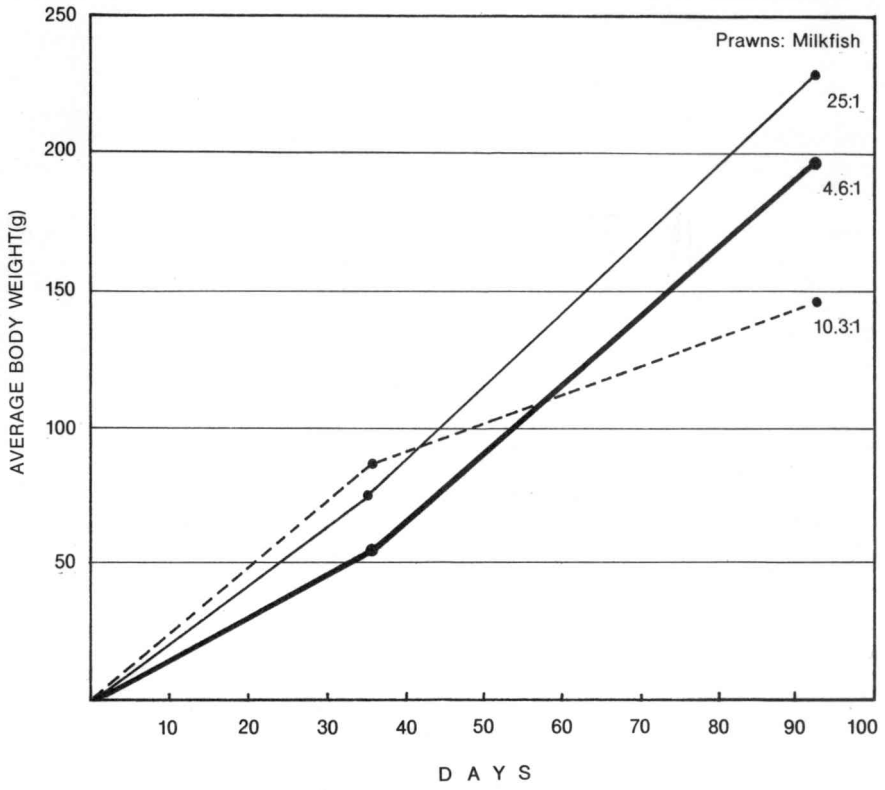
The traditional culture of bangos in Philippine brackishwater ponds yields an average production of less than 500 kg per hectare per year. To improve bangos yields, studies at the Leganes Station concentrated on critical areas of culture such as natural and supplementary feeding, and predator control.

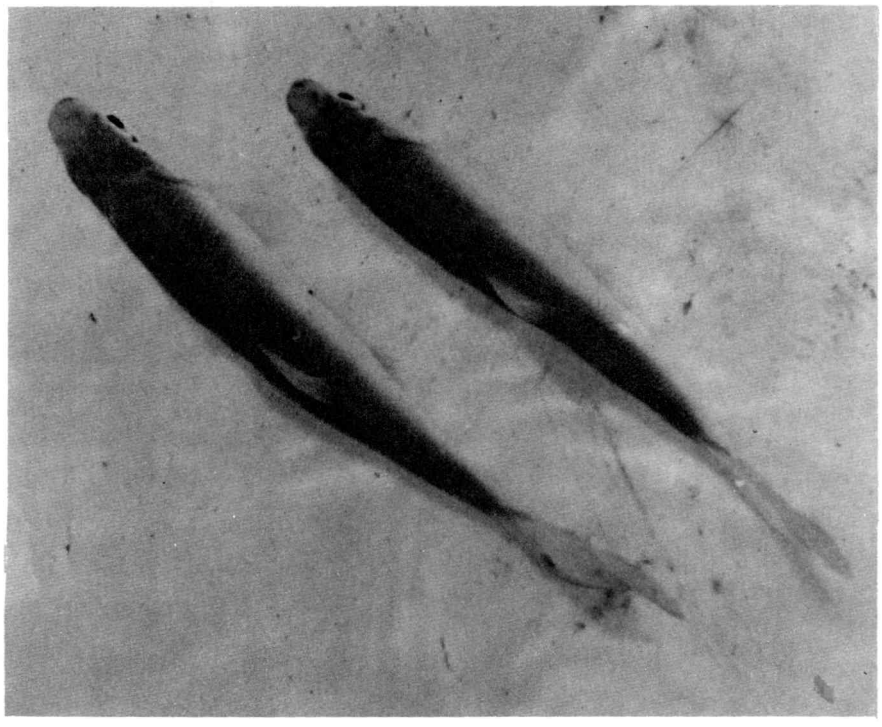
The micro-benthic *lablab* is an important natural food for all stages of pond-reared bangos.

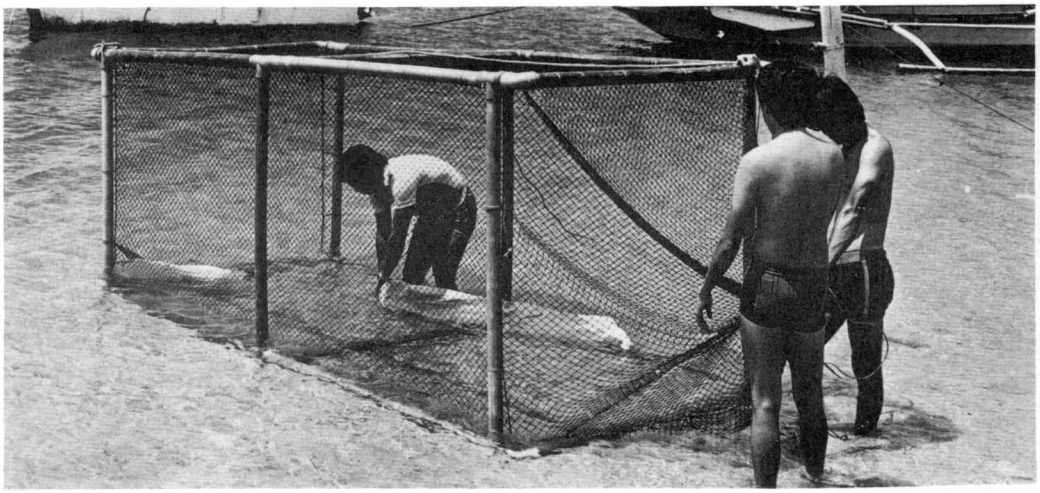
Studies on pelletized feeds using chitosan, gelatin and other binders showed that although milkfish fingerlings were attracted to the pellets, they failed to consume the feeds.

Initial results from a bangos-sugpo polyculture trial experiment are shown in Figure 8. Bangos grew best at the highest sugpo to bangos ratio of 25:1. Results also indicated that polyculture was an efficient way of utilizing the pond's carrying capacity, since there was no competition between the two species.

Fig. 8. Growth of milkfish in polyculture with prawns at different stocking ratios in a one-hectare rearing pond.

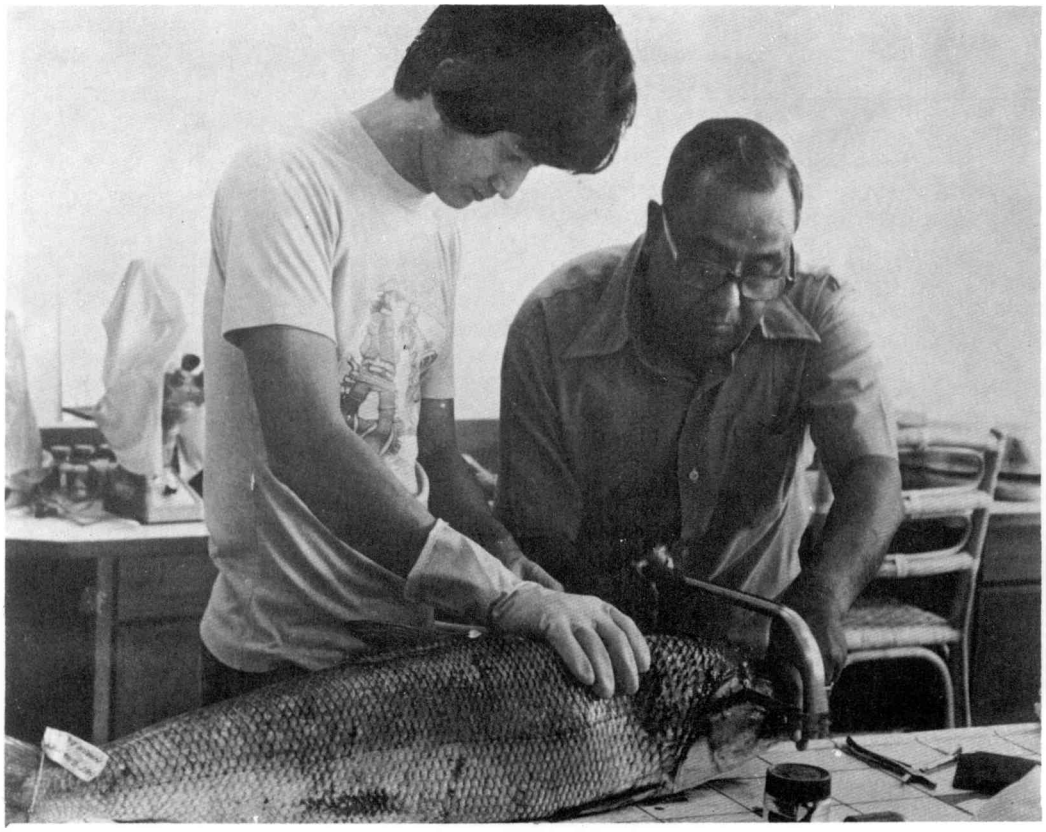




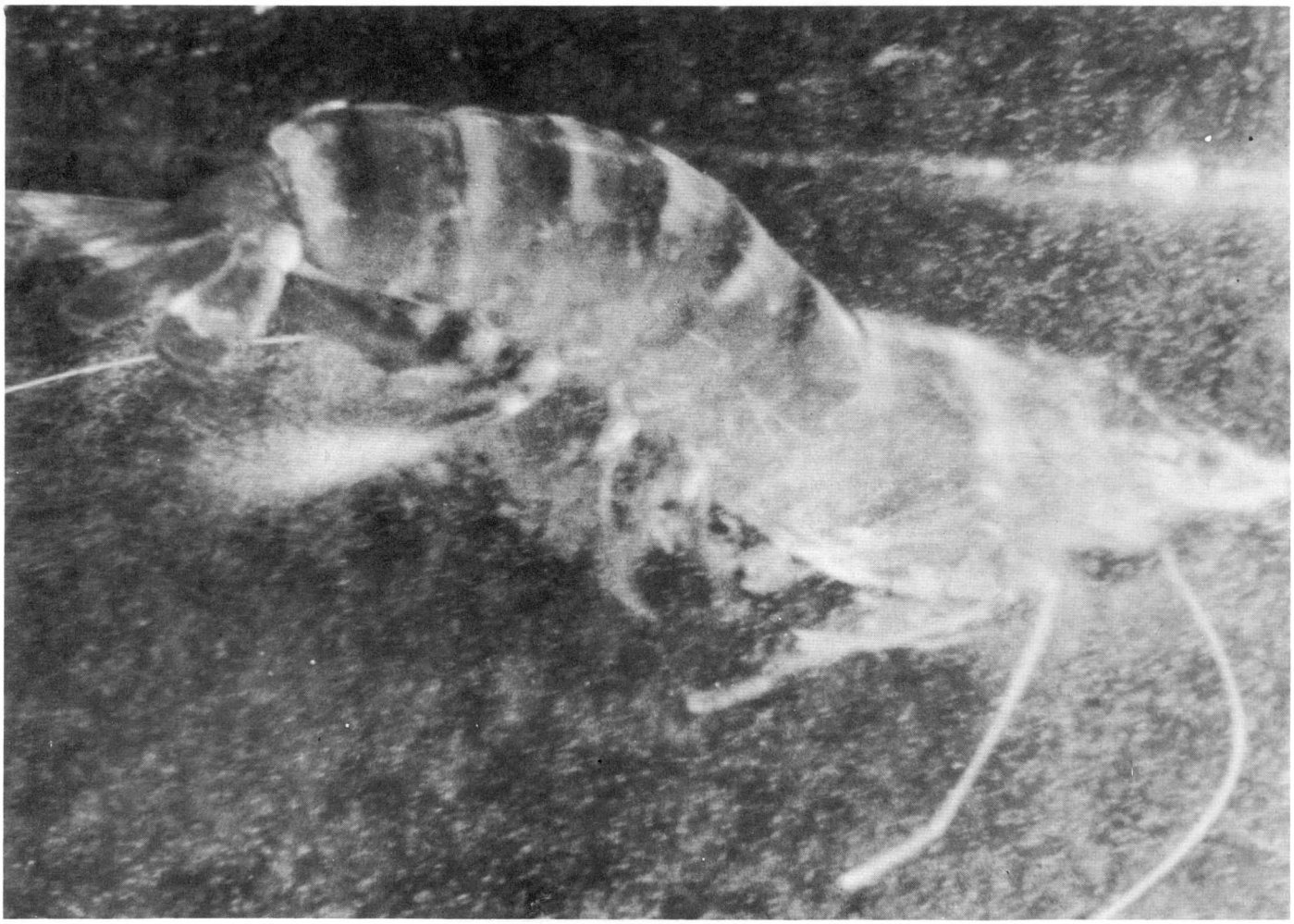


Method of transporting Sabalo perfected in Pandan Station

Inverting sabalo minimizes active movements



Removal of pituitary gland from Sabalo.



Spawning of sugpo may last one to seven minutes

Release of eggs can be forceful

PRAWN PROGRAM

• PROGRAM HIGHLIGHTS

With the reorganization of the research division into programs, all the various studies on shrimps and prawns were unified into one program. Related studies were integrated, gaps were filled and the various research projects were directed towards a common program objective: to modernize the technology of prawn culture through complete domestication of all stages and development of intensive rearing techniques. Major emphasis is directed toward sugpo, *Penaeus monodon,* but studies are also conducted on all other commercial penaeids.

Two major constraints were identified in the expansion and full development of the prawn culture industry: availability of fry and supply of quality prawn feed. With these two constraints serving as beacons to channel research directions, ten projects were organized under the prawn program.

Seed Production Project. Prawn has traditionally been a secondary crop to milkfish in the Philippines. Yet its economic importance has overshadowed milkfish as an export crop. Thus its potential to the Southeast Asian region as a dollar earning crop is well accepted. In order to popularize the farming of prawn as a primary crop a constant supply of fry is essential. The seed production project aims at producing fry for fishpond operators through a Fishpond Cooperator's Program organized by the Department's Training and Extension Division with the cooperation of the West Visayas Federation of Fish Producers, Inc.

Barangay Hatchery Project

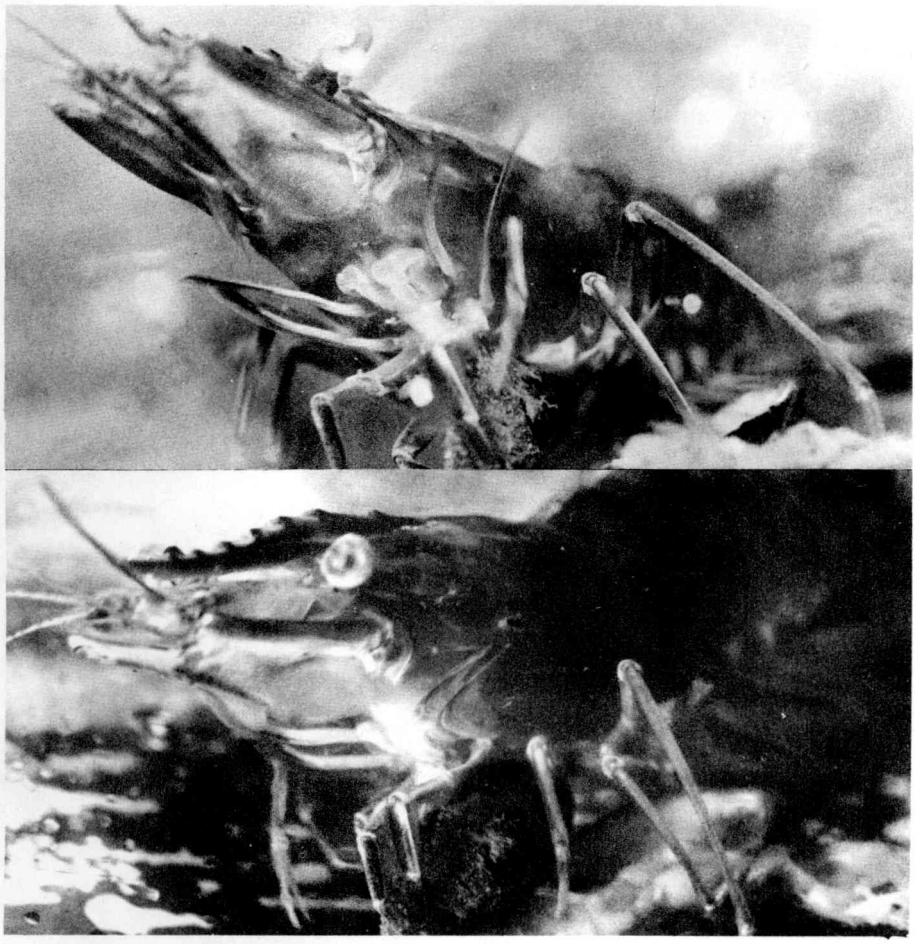
Ultimately it is the private sector itself which should produce the prawn fry to fill the needs of the industry. Towards this end the Barangay Hatchery Project was organized in order to effect the transfer of hatchery technology to the private sector. The project seeks to scale down the technology to a level which can be adopted by villages with a minimum of financial and technical input. Under the umbrella of this project experiments on various larval rearing schemes are also conducted.

Ecology and Life History Project

In developing the aquaculture of the prawn, basic knowledge on the biology of the animal is necessary Optimum environmental parameters, feeding habits, their association with other species, and other ecological factors need to be considered. The Ecology and Life History Project seeks to understand the nature of the penaeids in their own habitat and in so doing provide guidance in the development of prawn culture technology.

Broodstock Development Project

Real husbandry of prawns can come only with the elimination of the hunting phase which shifted from wild fry to wild spawner acquisition. The full domestication of prawn therefore depends upon



the development of a captive broodstock. Initial experiments showing the feasibility of inducing maturation of the *Penaeus monodon* in captivity made it possible to plan a full scale development of a captive broodstock to supply the spawner needs of prawn hatcheries.

Natural Feeds Project

The production of prawn fry depends on the availability of live food organisms such as diatoms, rotifers and brine shrimps. Identification, isolation and propagation of important food organisms for the prawn larvae are essential to the refinement of larval rearing technology.

Pathology Project

In an artificial ecosystem where density of the cultured organism is high, diseases can take a great toll. Identification, prevention and control of disease causing organism is essential in order to demystify mass mortalities and make larval rearing evolve from art to technology.

Nutrition and Feed Development

The launching of an intensive prawn farming system depends greatly on the availability of standardized feeds designed to meet the nutritional requirements of the prawn. While feed development depends upon knowledge of basic nutritional requirements, certain assumptions can already be made and on that basic test diets formulated. Basic nutritional studies and test diet formulation are being done simultaneously by this project.

Pond Research and Pond Production Projects

Although the work plan and activities of pond production and pond research projects are intertwined and interrelated, it was necessary to distinguish the two aspects of pond cultivation for the purpose of determining actual inputs into the production ponds. This is important in demonstrating the economic viability of any new culture technique developed.

Macrobrachium Special Project

The giant freshwater prawn, *Macrobrachium rosenbergii* has received considerable attention in the aquaculture world with the development of its larval rearing technique. Considering the abundance of the species in rivers within the region, and considering the scarcely tapped freshwater areas within the region, Macrobrachium farming holds a lot of promise.

● HATCHERY OPERATIONS

In October 1976, for the first time since its operation, the hatchery achieved a record production of 1.3 million fry in one tank from only 12 *Penaeus monodon* spawners. Production is equivalent to 108,000 fry per spawner. In 1975, the maximum production was only 6,620 fry per spawner.

Our most important innovation was on the feeding method. In the old process which was adapted from rearing method of *Penaeus japonicus*, diatoms predominantly *Chaetoceros* and *Skeletonema* which served as larval food were made to bloom in the larval rearing tank itself. In the new method, *Chaetoceros* and *Skeletonema* were reared in separate tanks, filtered through a sand filter and back-washed to remove excess fertilizers. The diatom concentrate was then pumped to the larval rearing tank where the water level was adjusted to maintain a minimum density depending upon larval stage.

Under the old method, excessive diatom bloom in the rearing tank

posed a problem. Uneaten diatoms die and foul the rearing water upon decomposition. The problem was solved by regulating light intensity in the rearing tank with the use of layers of black net.

Another problem we tackled was the accumulation of uneaten feed material and dead larvae on the tank bottom. Aeration wasn't enough to keep the organic particles in suspension. There was still accumulation of toxic gases from decomposition on the tank bottom as prawn larvae reached the clinging stage. But this was minimized with the use of electrically-driven mechanical agitators rotating at the rate of 2-3 revolutions per minute. The tank bottom was also checked daily after the mysis stage. Accumulated organic sediments were removed manually with a suction hose.

The quality of the rearing water was closely watched from the third zoeal stage. One half of the rearing water was changed daily. Only filtered seawater was used in rearing.

At this point, our basic approach to larval rearing of sugpo (Figure 9) will probably need only minor refinements to make the hatchery process more precise and repeatable.

● HATCHERY TECHNOLOGY TRANSFER

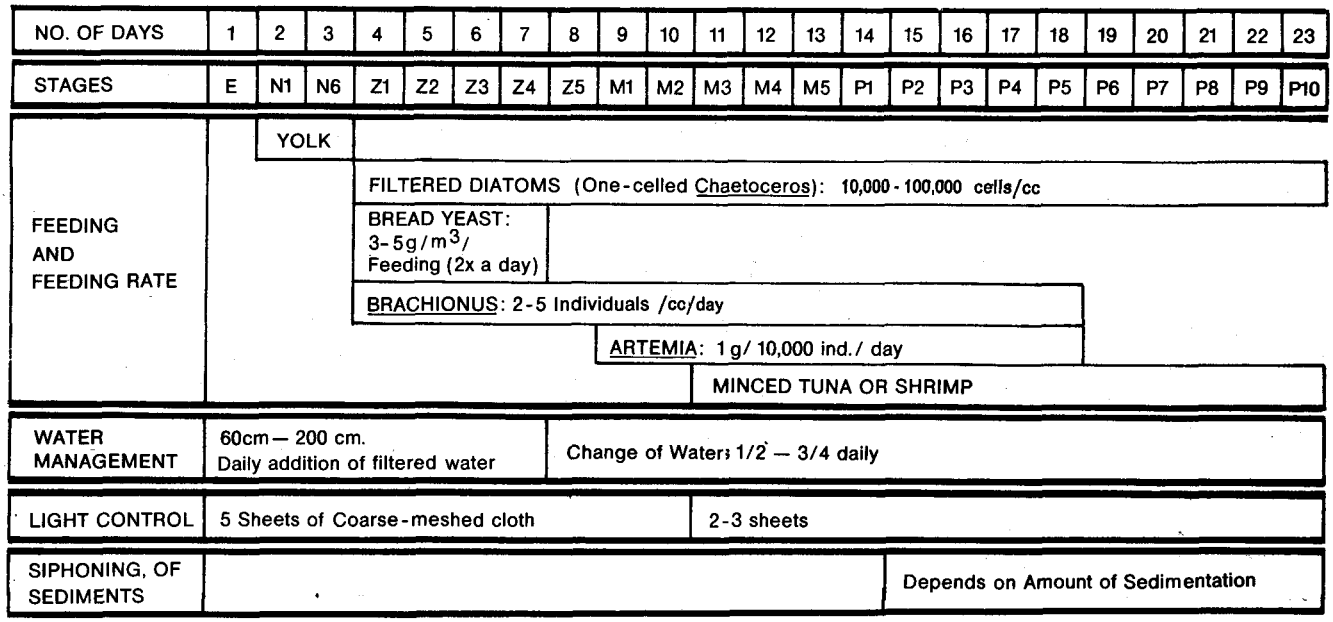
Our concrete hatchery tanks at Tigbauan, which are of three sizes, 50, 120, or 200 ton-capacity may be ideal for large-scale propagation but they require large material inputs for installation and operation. At this scale, the hatchery could be well beyond the financial capability of most Asian entrepreneurs and probably render commercial rearing less viable. Realizing this, we launched a project to bring the hatchery to the village level through the Barangay Hatchery System.

A barangay hatchery consists of small tanks made of marine plywood, designed in modules, which makes it expandable and transportable. A basic unit consists of a cylindrical 2-ton rearing tank, with a conical bottom to facilitate cleaning, draining and harvesting; two one-ton algal tanks for rearing diatoms; two one-ton *Brachionus* tank; and a one-ton *Chlorella* tank as well as a small compressor to provide aeration; and two sets of water pumps.

The system is still under development. But when it becomes fully operational, we plan to have a basic unit capable of producing 50,000 fry every month.

We are trying to simplify barangay hatchery technology to make it operational at the village level.

Fig. 9. Hatchery management procedure (In 200-ton outdoor tank experiments)



One basic concern is larval food. The present system of culturing planktonic feed like diatoms and rotifers calls for special technical skills in maintaining pure culture. We tried alternative feeding materials by using fermented kitchen wastes and vegetable trash as larval food and these show promising results.

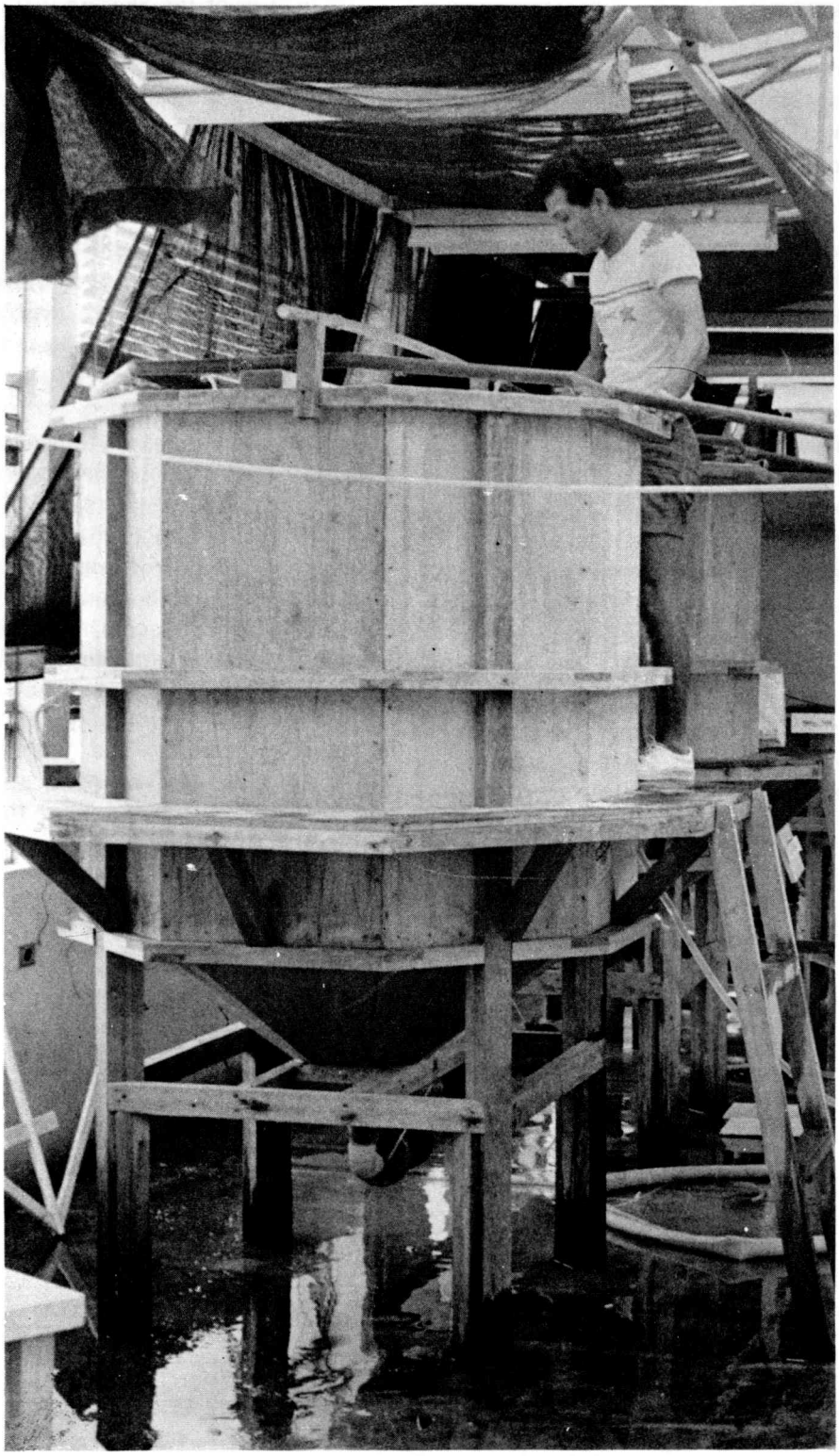
While we place great stress on studies to develop hatchery units which are most economical in terms of initial investment and operation, we are undertaking other studies to increase the production efficiency of hatchery units by using more sophisticated technology. We hope to come up with economic studies on production efficiency of hatchery units which use more sophisticated technology. Economic studies on production efficiency as a function of investment through use of specialized equipment will determine the commercial viability of the hatchery system.

● LARVAL REARING EXPERIMENTS

In order to improve our hatchery methods for *P. monodon* and other penaeids, continuing small scale studies are undertaken on the effect of various physical parameters on larval development. Two parameters found important in addition to temperature are light intensity and salinity.

In *P. monodon,* larval development was greatly affected by high light intensity. At 25,000 lux none of the experimental animals molted beyond the zoea stage. Light intensity of 2,000-5,000 lux was found to result in the highest survival rate up to postlarva, Table 8.

Similar results were obtained in experiments using *Metapenaeus ensis.*



Prototype of sugpo Barangay Hatchery Tank

Metapenaeus ensis which is known to be euryhaline during the juvenile to adult stage was found to require a narrow salinity range for successful larval development. At salinity of 18 ppt, only 2.6% metamorphosed to postlarvae, 66.6% at 24 ppt, 38.8% at 27 ppt and 11.9% at 30 ppt. The results also indicate that high salinity levels are ideal only before the mysis stage.

Feeds for Larval Prawns

In nature the larvae of penaeids feed on plant and animal plankton. Although artificial substitutes have been developed, these are at best used only as supplement, and in many cases are closely guarded trade formulations not available for general use. Shrimp hatcheries the world over still rely mainly on planktonic feeds. The maintenance and production of live feeds is a very important activity at the Aquaculture Department.

The Natural Feeds Project is concerned with three groups of organism: diatoms, the rotifer Brachionus, and brine shrimp, *Artemia salina* Activity on Brachionus is limited solely to the maintenance of a pure stock for use as starter for mass culture. Interest on brine shrimp propagation is high due to the high value of the imported brine shrimp cyst. The pilot brine shrimp production using intensive rearing techniques in raceways shall be initiated upon the arrival of consultants from the University of Ghent, Belgium.

Basic studies on diatom propagation can be divided into different aspects: selection and isolation of suitable local species, formulation of appropriate media for use in both the test-tube scale and mass scale, harvesting and storage of diatoms for later use.

During the early stage of hatchery operations, the diatom species used was *Skeletonema costatum* with starter coming from Japan. Skeietonema has a low temperature range requirement and is suitable in the Philippines only during the colder months.

A preliminary survey of the naturally occurring species of marine diatoms along the shoreline of Buyuan beach near SEAFDEC station showed the preponderance of *Navicula* spp., *Nitzschia* spp. and *Chaetoceros* spp. Of these, the unicellular species of *Chaetoceros* was considered most promising because of its small size (4-5 u diameter) and adaptability to varying environmental conditions. Hence, concentrated effort was focused on this organism to determine the optimum conditions for culture.

Volumes of *Chaetoceros* cultures were gradually increased from 10 ml (test tubes) to one ton fiberglass tanks. Maximum cell density of 5.7 million cells/cc in one liter bottles and 3.8 million cells/cc in 200 liter tanks were obtained. The organism reached its peak population on the third day. Daily replenishment of the medium supported good growth. Increase was 148.7%/day with daily replenishment of the medium compared with 35.6%/day with no replenishment.

Varying levels of nitrogen, phosphorous, silicon, vitamins B_1 and B_2, and micronutrients were tested on *Chaetoceros* sp. Based on its optimum nutrient requirements, a medium was formulated to promote high density cultures of the organism up to the 200-liter tank cultures.

Inexpensive and locally available fertilizers were utilized for growing starter cultures in one-ton fiberglass tanks (one-ton cap.). These served as the inoculum for the big hatchery tank diatom cultures (100-ton capacity) which are fed penaeid larvae up to harvest.

Very dense cultures of *Chaetoceros* sp. were harvested by using aluminum sulfate as the flocculating agent. The diatom

Table 8. Effect of light intensity on larval development of Penaeus monodon

Light Intensity (Lux)	Nauplius (No.)	No. reaching post larvae	Metamorphosis rate (%)
25,000	120	0	0
5,000	120	65	54.1
2,000	120	64	53.3
800	120	59	49.1

slurry (25 million cells/cc) was packed in plastic bags and stored in the refrigerator at 0°C. Frozen diatoms were acceptable to penaeid larvae. They survived and multiplied in the rearing medium. There was no significant difference between feeding larvae with frozen and fresh *Chaetoceros* sp.

Larval Diseases

Hatchery operations still experience heavy mortality during the zoeal and mysis stages.

One factor was the occurrence of diseases and other infestations in tank water.

We are developing a technique for predicting the outbreak of diseases in hatchery tanks. Our first concern was to analyze bacterial population in natural hatchery water. Out of fifty six (56) isolates, thirteen (13) or 23.0% were Gram-positive, and thirty-three (33) or 59.0% were Gram-negative (Table 9).

To isolate bacteria from the hatchery water, we tried three salt-free media: Backmann's Gliding Motility Agar (GMA); Standard Tryphone Glucose Yeast Extract Agar (TGYE); and Nutrient Agar (NA), (Table 10).

In another experiment, we used NA fortified with three levels of salt. Table 11 shows that 3.0% of salt added in seawater agar isolated a greater number of bacteria.

In another case, we tried to eliminate sulfide-producing organisms by using Kligler Iron Agar (KIA); Sulfide Indole Motility Agar (SIM); and Triple Sugar Iron Agar (TSI), (Table 12).

Table 9. Bacterial population in hatchery water (Based on 56 isolates)

	No. of isolates	Percentage
Gram -positive isolates:		
Micrococcus	6	10.8
Corynebacterium	1	1.8
Peptococcus	1	1.8
Bacillus	1	1.8
Gram - negative isolate:		
Acinetobacter	11	19.8
Flavo bacterium	1	1.8
Moraxella	7	12.6
Photobacterium	1	1.8
Plesiomonas	3	5.4
Pseudomonas	4	7.4

Table 10. Suitability of three media in the recovery of bacteria from hatchery water

Plating Dilutions Included	Total Plate Counts in Media		
	TGYE	NA	GMA
$10^{1} - 10^{4}$	7.2×10^{3}	4.7×10^{3}	1.4×10^{4}
10^{4}	4.5×10^{3}	4.8×10^{2}	2.0×10^{4}
$10^{3}, 10^{4}$	5.8×10^{3}	2.1×10^{2}	1.6×10^{4}

Table 11. Recovery of bacteria in NA fortified with three levels of salt

Salt Concentration	Total Plate Count	Variability of Isolates
2%	2.275×10^{3}	Varied
25%	6.250×10^{2}	—
30%	4.775×10^{3}	Not varied; Colonies very small

Table 12. Recovery of sulfide-producing bacteria

Medium	Mean Total Plate Count in 10^{0}	Mean Total Plate Count in 10^{1}	Mean Total Plate Count
SIM	13	0	13
TSI	25	1	23.2
KIA	232	33	281

Ectoparasites of Sugpo Larvae

The appearance and disappearance of ectocommensals in sugpo larvae gave us leads in predicting major causes of the mass mortality in hatchery tanks.

On February 9, 1976, we detected for the first time, a new disease in a population of sugpo mysis, caused by the suctorean parasite, *Ephelota gemmipara,* a species commonly found to inhabit hydroid colonies. This protozoan reproduces by multiple exogenous budding.

Daily observations were carried out until June 1976. A total of 15 hatchery runs was affected by the pathogen, which appeared in streaks lasting 2 to 3 days between intervals of 4 to 25 days.

When it attached to the larvae, the suctorean irritated and drained the host of cellular materials. During the early stages of infection, the hosts were normally active as they kicked violently, perhaps an attempt to shake off the pathogens. But the hosts grew weak after repeated brushes with the irritants. Then liquids were extracted from the cytoplasm by the combined action of the sucking and piercing tentacles of the pathogen. The hosts became listless and lethargic. Their feeding activity was reduced to a minimum, then death eventually occurred.

We studied a sample consisting of the first 100 infected larvae. The results show that 55 in the zoeal stages had a total of 95 *Ephelota* bodies for a mean infection load of 1.73 per host (Table 13). Each host had at least one *Ephelota* while three individuals with the heaviest infection had a total of 11 each. Thirty five were in the mysis stage, parasitized by a total of 58 *Ephelota* for a mean load of 1.66. However, in the postlarval stages (10%) where no case of multiple attachment was found, mean infection load was 1.00.

The protozoans attached themselves to broad and relatively immobile parts, such as body segments, carapace, and uropods in both zoea and mysis stages (Table 14).

We continued to detect the occurrence of the fungus *Lagenidium.* This was seen in 35 out of 51 hatchery runs, 22 of which had to be discarded. This fungus has the innate property of reproducing asexually by zoospores which explains its rapid spread. When the reniform biflagellated zoospores were released, these were picked up by the larvae. The zoospores germinated and affected all portions of the body except the eyes.

We also detected another parasite, *Licmophora abbreviata,* a pennate diatom, which caused lesser problems than the others as it was usually shed off with the exoskeleton during the molting. Its occurrence in great number overburdens the larvae. Prolonged attachment led to loss in feeding ability of the hosts. It oftentimes resulted in death.

Three other protozoans, *Vorticella, Zoothamnium* and *Acineta,* occurred in 30, 18 and 15 hatchery runs, respectively. No clear-cut incidents of mortality can be directly imputed to them. These commensals showed preference of attachment to the anterior portions of the exoskeleton such as the antennae, antennules and the rostrum, resulting in discomfort to the host but its feeding activity was not disrupted.

Table 13. Comparison of Ephelota gemmipara infection loads among three stages of sugpo larvae

Stage	No. of Specimens Infected	No. of *Ephelota* Attached	Infection load / Specimen
Zoea	55	95	1.73
Mysis	35	58	1.66
Postlarva	10	10	1.00
Total	100		

Prophylactic Chemicals for Disease Control

It has been established that chemicals and antibiotics may be used as prophylactic agents for the control of parasites and diseases in both larvae and spawners.

We bioassayed the tolerance of artificially-spawned sugpo larvae to the antibiotic 'furanace'.

Sugpo mysis exposed to 1 ppm bath had a mean survival rate of 60%. Those exposed to 2 ppm had only 50% and 3 ppm, 35% survival (Table 15).

Experiments were also conducted to ascertain morphological and development effects of a 24-hour exposure to three different concentrations on the larvae. The results indicate a delaying effect on metamorphosis (Table 16). For Z_1 to Z_2, larvae bathed in 1 ppm concentration, 70% metamorphosed successfully. With a dose of 2 ppm, only 14% showed successful metamorphosis. However, there appears to be a delaying effect of the antibiotic with larval stages Z_2 to Z_3. In Z_3 to M_1, development was not affected by a dose of 1 ppm but was markedly affected by a dose of 2 ppm.

Examination of the larvae for morphological changes revealed some damage, deviant allometry, hypertrophy and other conditions (Table 17). For example, the Z_1 to Z_2 ecdysis were accompanied by abnormally-shaped uropods, spread carapace, and broken setae. Metamorphosis from Z_2 to Z_3 was affected by the damaged telson. During the Z_3 to M_1 transition, we observed abnormalities of the

Table 14. Distribution of Ephelota on various body parts of sugpo larvae

Body Parts	Stages		
	Zoea	Mysis	Postlarva
Body segments:			
1st	2	0	0
2nd	3	5	1
3rd	4	2	0
4th	4	2	1
5th	4	4	0
6th	42	11	1
Antennae	6	1	0
Antennules	1	1	2
Rostrum	1	6	0
Eyes	2	6	0
Carapace	5	7	1
Gills	1	1	0
Telson	13	6	1
Uropods	7	5	1
Pleopods	—	1	1
Pereiopods	—	—	1
T o t a l	95	58	10

Table 15. Tolerance of sugpo larvae to various levels of furanace (Furanace added in bath for 24 hours)

Stages	Dose (ppm):	Mean Percentage Survival 0	1	2	3	Interpolated LD_{50}
$Zoea_2$		80.3	65.3	36.5	0	1.6
$Mysis_1$		66.5	69.0	49.8	34.8	2.0
$Postlarva_1$		84.8	83.6	81.5	76.8	5.0

Table 16. Metamorphosis of sugpo larvae at two levels of furanace (Furanace added in bath for 24 hours)

	Levels of Furanace (ppm)		
Z_1 to Z_2: Z_1	3	38	37
Z_2	177	89	6
Percentage	0.983	0.701	0.139
Z_2 to Z_3: Z_2	7	22	75
Z_3	94	144	74
Percentage	0.931	0.867	0.528
Z_3 to M_1: Z_3	13	33	57
M_1	89	148	87
Percentage	0.872	0.818	0.614

Table 17. Morphological defects found in sugpo larvae larvae exposed for 24 to 2 levels of furanace

Experiments	Center of Morphological Defects	Number of Individuals Showing Morphological Defects in Levels of Furanace		
		0	1	2
Z_1 to Z_2:	Carapace	2	0	1
	Telson	5	3	2
Total Individual Examined:		248	178	77
Z_2 to Z_3:	Carapace	2	3	6
	Telson	3	6	19
	Uropods	2	2	1
Total Individuals Examined:		102	166	159
Z_3 to M_1:	Carapace	18	3	35
	Telson-Uropods	15	2	20
	Uropods	3	3	10
	Telson	6	5	4
	Pereipods	9	3	16
	Antennae	11	0	5
	Rostrum	12	1	0
Total Individuals Examined:		102	168	144

carapace, antennae, uropods and pereiopods.

Weak and disease-infected Z_2 and M_1 populations were exposed to various dosages of furanace at different lengths of time. Our data (Figures 10 and 11) show no significant reduction in populations in all the concentrations after 24 hours; differences were apparent only after 48 hours. Highest mean survival rate after 96 hours was attained by the M_1 larvae exposed to furanace for 6 and 9 hours. There was no significant mortality observed among the zoeal population after the 24-hour observation period.

Various dosages of formalin were tried on *Lagenidium*-infected larvae. Results show that during the zoeal stages, 1 ppm gave higher survival rates, at the mysis stage, 0.1 — 1 ppm, while in the postlarval stages, 10 ppm was presumed optimal.

In another experiment, we tried various concentrations of calcium hypochlorite which were added in bath or in the water with which the spawners were packed in transit. We observed that a 5 ppm concentration was fairly effective, and exposure to the chemical for at least 46 minutes resulted in a 99% inactivity of the fungal load.

Fi. 10. Survival of sugpo zoea exposed to varied durations in 1 ppm furanace

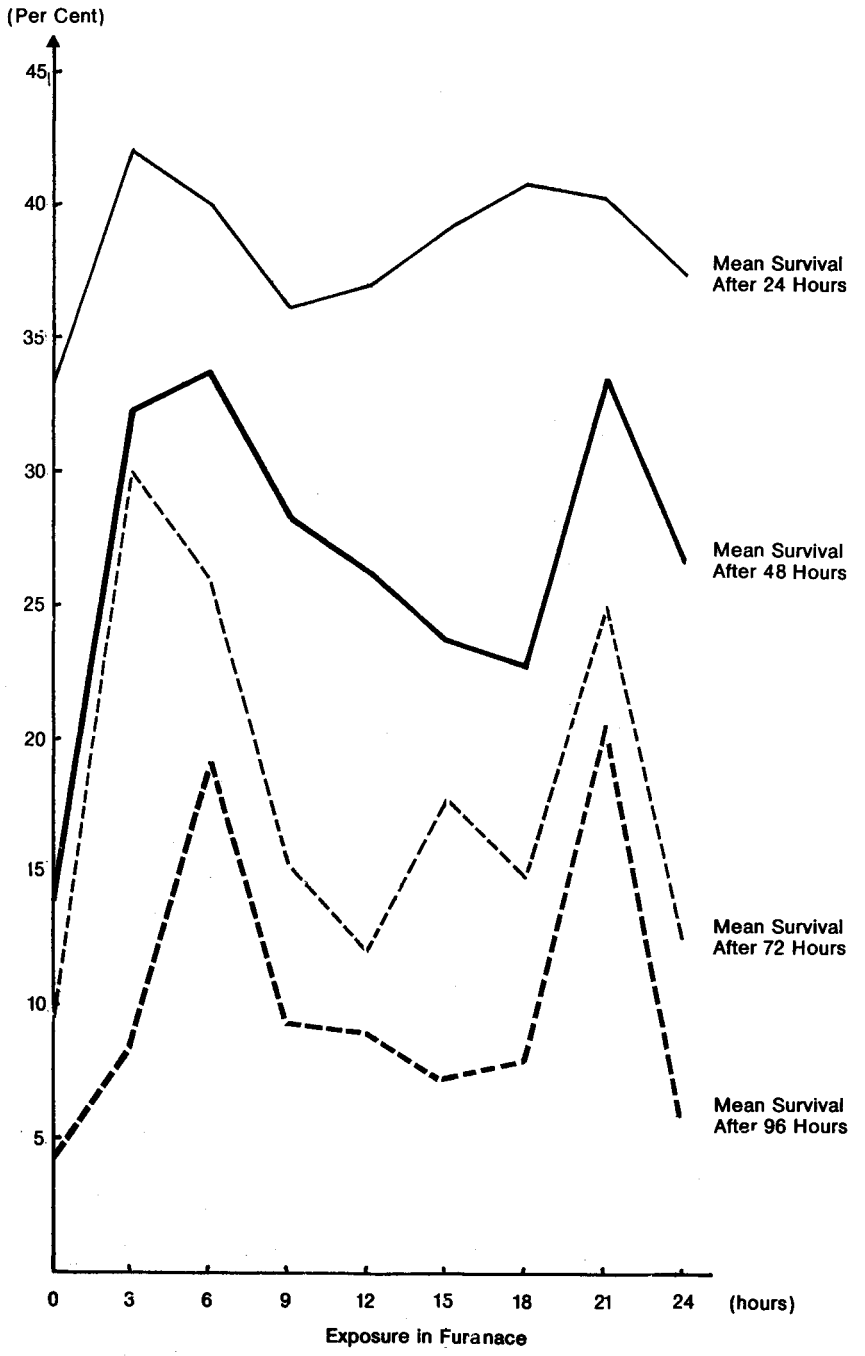
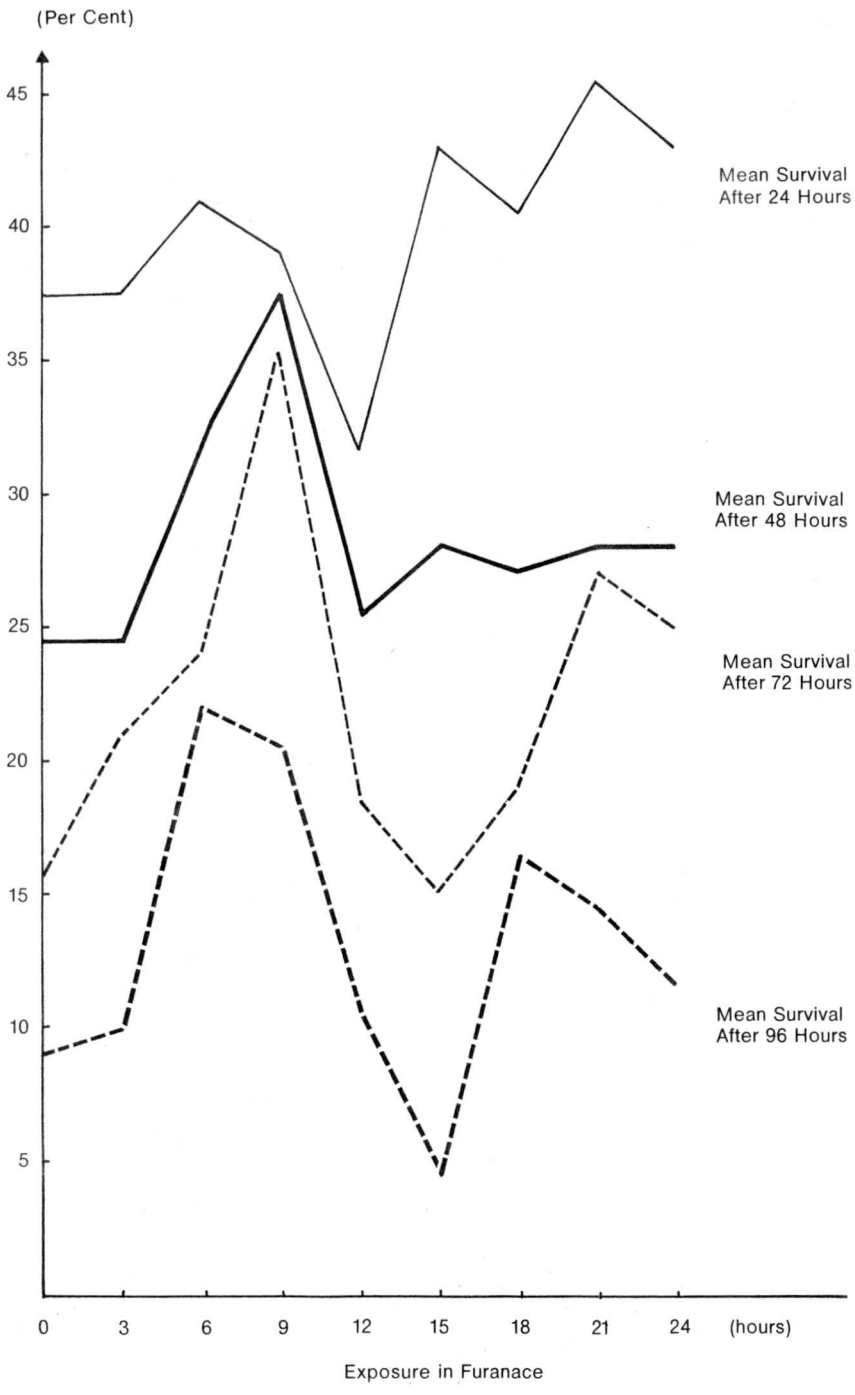
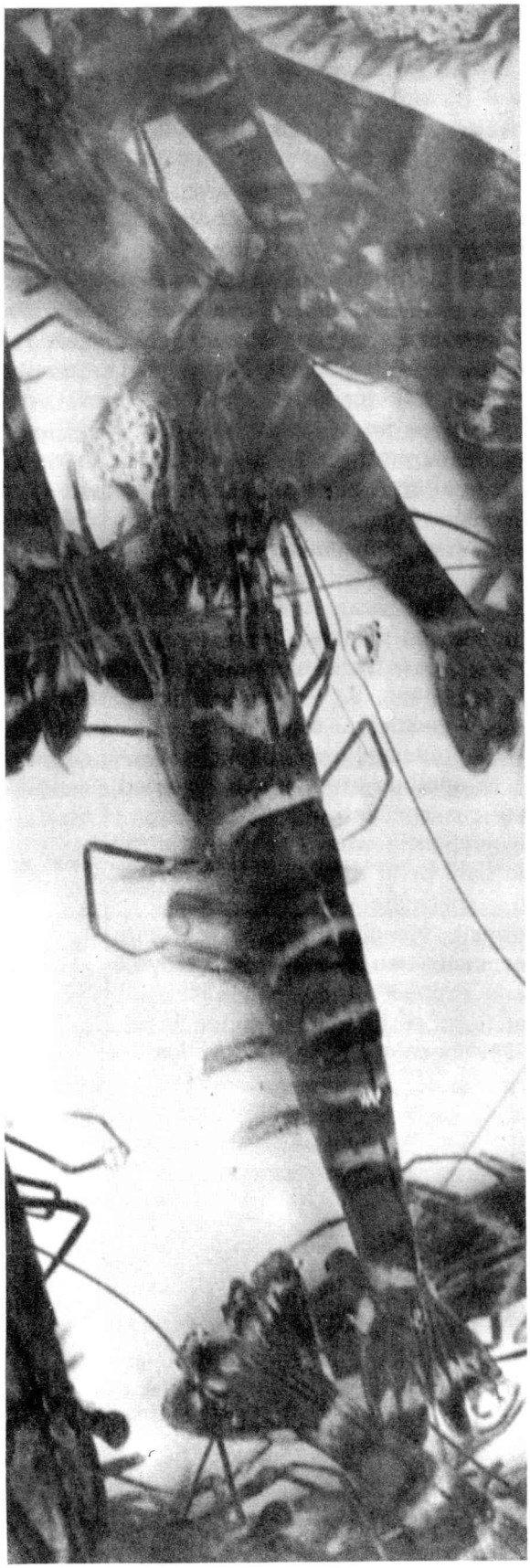


Fig. 11. Survival of sugpo zoea exposed to varied durations in one ppm furanace





Sugpo Broodstock Development

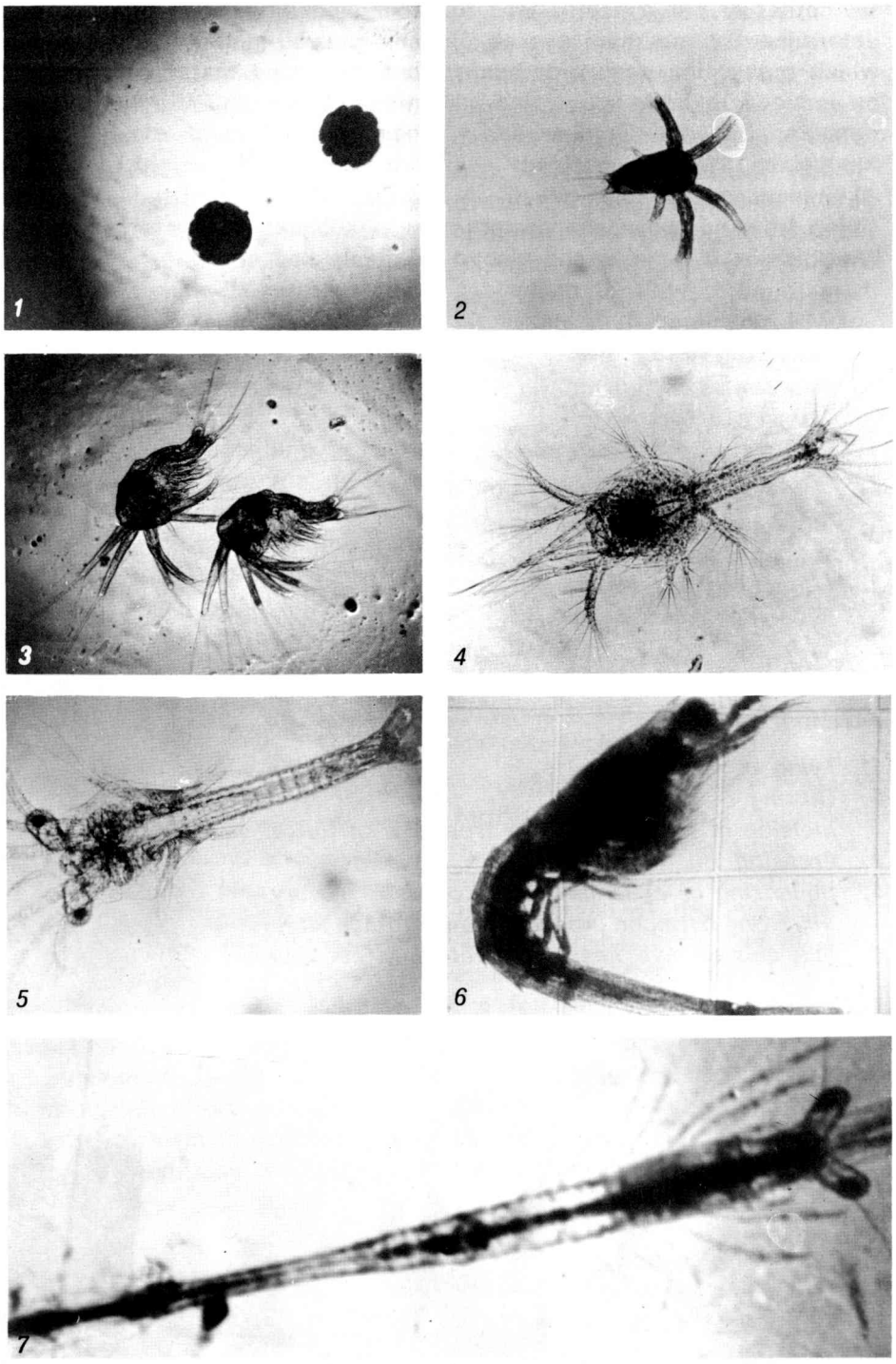
The first successful completion of the life cycle of *P. monodon* which was achieved in December 1975, played a major role in minimizing the acute shortage of sugpo spawners for our hatchery. It enabled us to improve and develop further maturation and rematuration techniques in our floating cages. Possibilities of land-based maturation and broodstock maintenance were also assessed with the barangay sugpo hatchery in mind.

In both maturation and rematuration experiments, a technique known as unilateral eyestalk ablation was used, but we are still improving ablation techniques to reduce mortality. We used three different methods of ablation — cutting off the eyeball and eyestalk; tying of the eyestalk; crushing the eyestalk after emptying the eyeball through an incision.

The last method was found most satisfactory. It involved making an incision across the eyeball to allow free flow of fluids and squeezing the eyestalk tissue to destroy the production and storage sites of the gonad-inhibiting hormone.

We developed new tagging method to identify the experimental animals to follow individual patterns of ovarian development. From May to September 1976, we tagged 348 spent and immature females and stocked them in floating cages. We used brass tags, 5 x 20 mm, rolled around the unablated eyestalk like a small bracelet.

Parallel to our floating maturation cages, we used 4-ton wooden tanks with coralline sand substrate and airlift to provide water movement. These tanks allowed us a closer monitoring of ovarian development.



P. monodon 1. Egg 2. Early nauplius 3. Late nauplius 4. Early zoea 5. Late zoea 6. Mysis 7. Postlarva

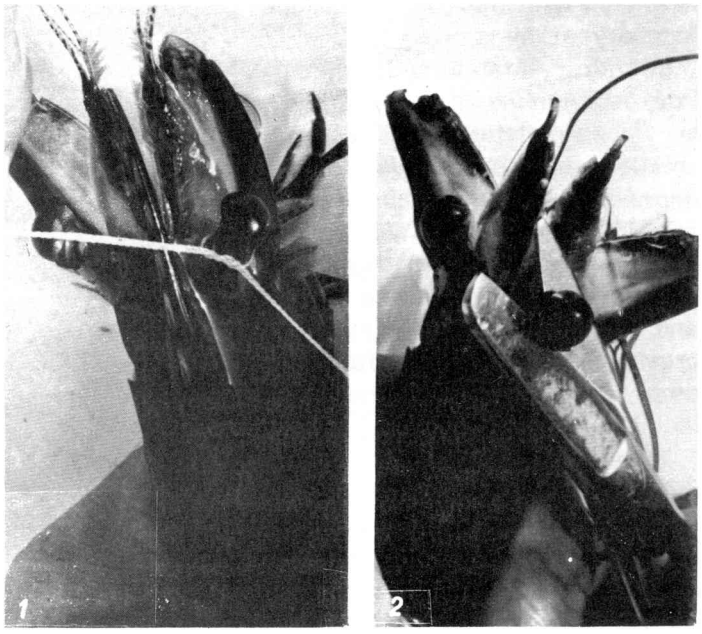
Another of our concerns was to determine the minimum age at which maturation occurs or can be induced in both males and females. Between October and November 1976. we obtained 40 nine-month-old, pond-raised sugpo from our pond cooperators. We ablated 10 females and placed them together with 20 males and 10 unablated females in a race way system. After four weeks, we did not observe any gonadal maturation in females, but we noted that induced maturation might still have been possible in 9-month old females with mean body weight of 64.7 grams, if the pelletized diet given was adequate because the animals had a low survival and demonstrated a marked decrease in body weight.

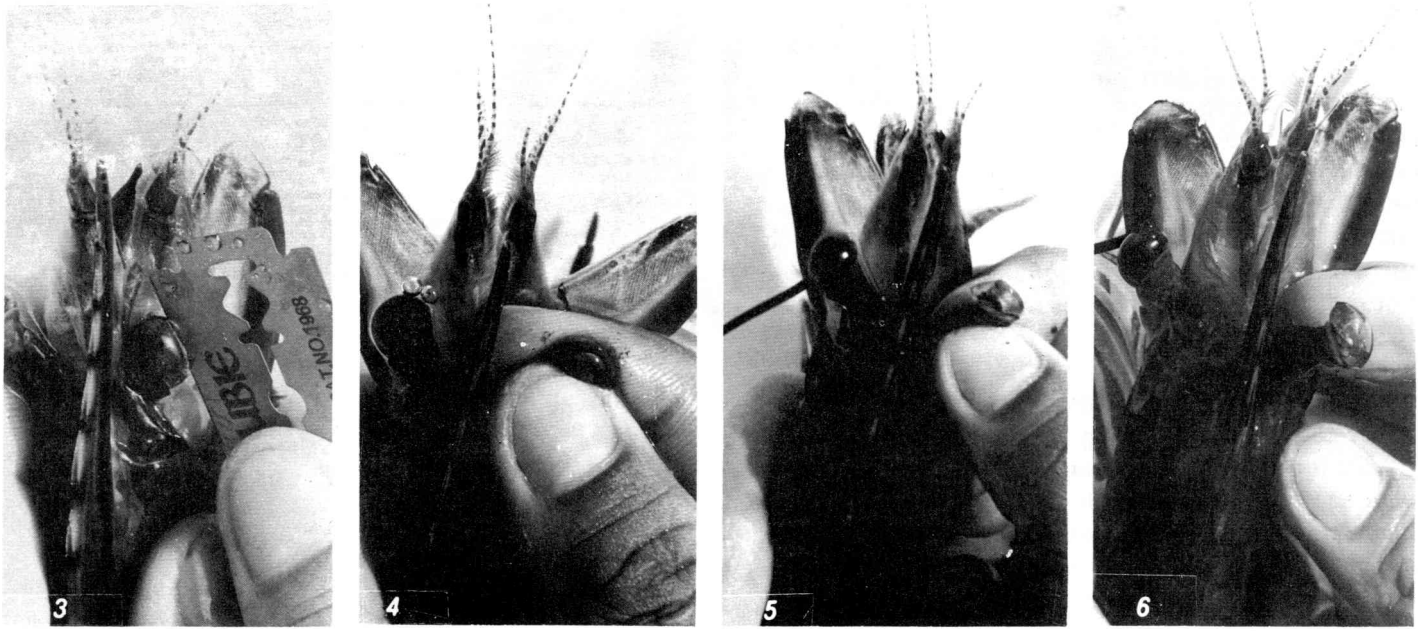
At this writing, no conclusions on age-linked maturation in reared females could be drawn because of the unavailability of sufficient number of experimental stock with known age.

Our studies on males are more fruitful. They show that males attain sexual maturity when they are around 40 grams, body weight. Males weighing over 45 grams were invariably mature and presumably capable of suc-

Ablation Techniques:

1. *Tying of eyestalk*
2. *Cutting of eyestalk*
3. *Incision of eyeball to allow free flow of fluids*
4. *Pressing the eyeball contents outwards*
5. *Squeezing of eyestalk tissue to destroy ovary inhibiting hormone production and storage sites*
6. *The ablated eye heals completely in about a week*





cessful insemination of females. Age appears to be relevant in the attainment of maturity in males.

In the absence of sufficient stocks of known age, we decided to use stocks of known body weights instead. In November 1976, we collected a sufficient number of experimental sugpo and classified them into three body weight categories: 60-79 g, 80-99 g and 100 g. These were stocked in small aquaria and wooden tanks fitted with air-lift filtration systems through graded coral sand. One half of the water in each container was replaced daily.

The small aquaria experiments were set up with ablated and tagged females with an appropriate number of unablated and untagged controls. Each wooden tank experiment used 20 wild female stock from Batan Bay and 20 males from Leganes ponds. Ten females were ablated and tagged; 10 other females, unablated and untagged. Twenty were mature males.

During a four-week observation period, the animals in the small aquaria did not exhibit gonadal maturation. On the fourth week mortality was very high, which may be due to occasional aeration failure and stress during handling.

On the other hand, the animals stocked in the wooden tanks exhibited very promising results (Table 18). On December 8, 1976, one 100 g ablated spawner produced 128,500 eggs in two partial spawnings, which hatched into 103,200 viable larvae. Another spawning occurred with 76 g ablated females which developed gonadal maturation from Stage I to Stage IV in 6 days. The female spawned with some difficulty because of the low water temperature during that time. Fungal infection prevented the fertile eggs from hatching. Subsequently, a 67 g ablated female developed gonadal maturation from Stage 0 to Stage II in 9 days and from Stage III to Stage IV in one day. This spawner, with about 150,000 to 180,000 apparently normal eggs, was ready to spawn when an accidental water draining caused its death. More gonadal developments are now under close observations.

Further results also showed that in general, females molt at an average of once every 18-21 days, while the males, every 23 to 30 days. Fifty per cent of all molting occurred during each phase of the moon. In other words, fifty per cent of its molting occurred over a period of 12 selected days of each month. Our sampling and handling of the broodstock were confined to those days in which molting did not occur.

● ECOLOGICAL SURVEY

While maturation and rematuration experiments were still being perfected, we had been dependent on the natural sources for our sugpo spawner requirements. Substations were established to collect spawners.

Through our surveys, we observed Batan Bay and its adjacent waters as most productive for wild spawners. It has provided at least 150 sugpo spawners per month.

In 1976, we utilized 703 sugpo spawners. Of these, 58% came from Batan Bay. Among them, partial spawning was prevalent. The rate of complete spawning was 17 per cent, which is low. Forty per cent were collected from Himamaylan. These were of better quality. There was complete spawning at the rate of 57%, but these spawners cannot be collected in large quantity.

Table 18. Gonadal development in land-based maturation system using wooden tanks

Weight of Spawners Used (g)	Mortality		Molting			Gonadal Development
	Per Cent	Culture Period (weeks)	Frequency		Cycle (days)	
			F	M		
100 +	20	4	1.5	1.0	30	55% (80 % ablated and 30% unablated females) showed gonadal maturation after 4 weeks.
80-99	15	4	1.4	1.0	25	15% ablated females showed gonadal maturation within three weeks from ablation.
60-79	10	3	1.0	1.0	21	60% ablated and one unablated females showed gonadal maturation within three weeks from ablation.

Since Batan Bay is a major source of sugpo spawners, we undertook a series of surveys to study the oceanographic conditions of the Bay, its penaeid composition, and the distribution pattern of various penaeid species in the Bay.

Batan Bay (Figure 12), situated in the northern part of Panay Island, 11°40'N and 122°30'E, is about 2,450 hectares. Its bottom is soft, consisting of silt and fine sand.

There are two families of shrimp in the Bay area: Sergestidae and Penaeidae, with 21 species namely, *Acetes* sp., *Lucifer* sp., *Penaeus monodon, P. semisulcatus, P. merguiensis, P. latisulcatus, P. japonicus, Metapenaeus ensis, M. endeavori, M. burkenroadi, Metapenaeopsis palmensis,* and *Trachypenaeus fulvus.*

The most important activity in the Bay is shrimp fishing and the gears in use are fish corrals, filter net, set net, skimming nets, baby trawl and level net (Table 19).

● DEVELOPMENT OF PRAWN FEED

During the year, we continued our search for artificial feeds that would meet the nutritional requirements of sugpo.

Feed formulations were developed from plant and animal sources preferably those that are not utilized as human food, but we have now shifted our priority to center on the production of pellets for pond use. One major problem is to find a suitable binder to hold the pellet in form after immersion in water. We are assessing corn starch; cassava starch, agar, gelatin, sweet potato flour, ipil-ipil leaves and chitosan as possible binders. Chitosan was extracted from dried, finely ground crab and shrimp shells following standard procedures. There was 5.5% and 3.5% recovery from crab and shrimp shells respectively. Pellets made with the chitosan binder were eaten by prawns.

Solubility test for the pellets showed that chitosan, camote flour and gelatin remained afloat for one hour and disintegrated shortly after sinking while pellets prepared with ipil-ipil and corn starch sank and did not disintegrate until after 18 hours.

The feeding efficiencies of various feed combinations using dried shrimp head, soybean meal and rice bran were assessed. The result showed a conversion rate of 1.9 for the shrimp head-rice bran combination as against 2.9 for shrimp head-soybean cake and

Fig. 12. Map showing Batan Bay

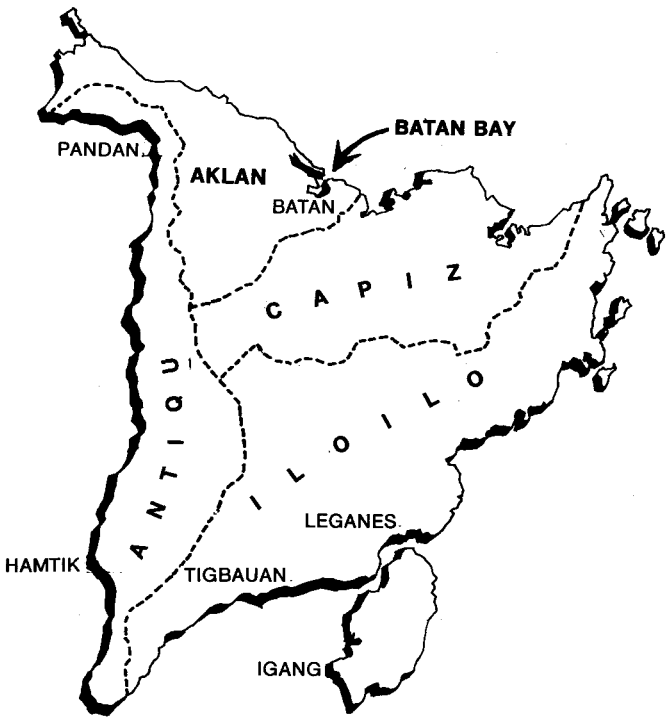


Table 19. Shrimp catch composition in Batan Bay

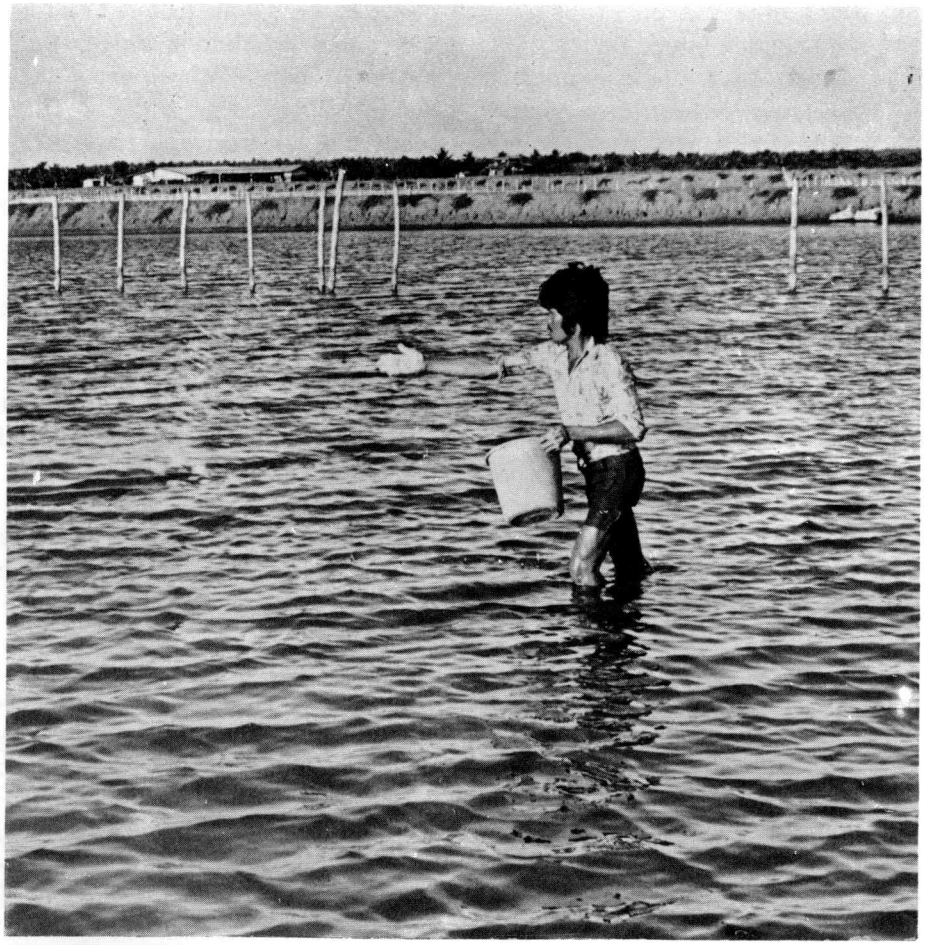
	Fishing Gears Used											
	Fish Corral		Skimming Net		Baby Trawl		Filter Net		Lift Net		TOTAL	
	M	F	M	F	M	F	M	F	M	F	M	F
P. merguiensis	42	107	205	113	3	10	3	2	0	0	253	232
P. semisulcatus	36	34	50	66	6	20	2	7	0	0	94	127
P. latisulcatus	13	22	0	0	0	0	1	1	0	0	14	23
P. monodon	20	24	8	6	3	3	0	0	0	0	31	33
P. japonicus	0	1	0	0	0	0	0	0	0	0	0	1
M. ensis	26	98	169	299	107	113	147	130	3	8	452	648
M. burkenroadi	6	14	15	20	68	235	144	262	0	4	233	535
M. endeavouri	3	11	1	1	0	0	0	2	0	0	4	14
Met. palmensis	0	0	0	0	1	1	8	22	0	0	9	23
T. fulvus	1	4	0	1	00	3	33	63	0	0	34	71
TOTAL	147	315	448	506	188	385	338	489	3	12	1,124	1,707

2.8 for shrimp head-soybean cake-rice bran combinations during the first month of rearing inside 400-liter fiberglass tanks. The experiment was continued for 82 more days during which time growth was slow due to overcrowding since survival ranged from 50 to 73% from an original stocking density of 750 animals in 150 liters of seawater. The feeds need to be tested in ponds in order to fully evaluate their efficiency.

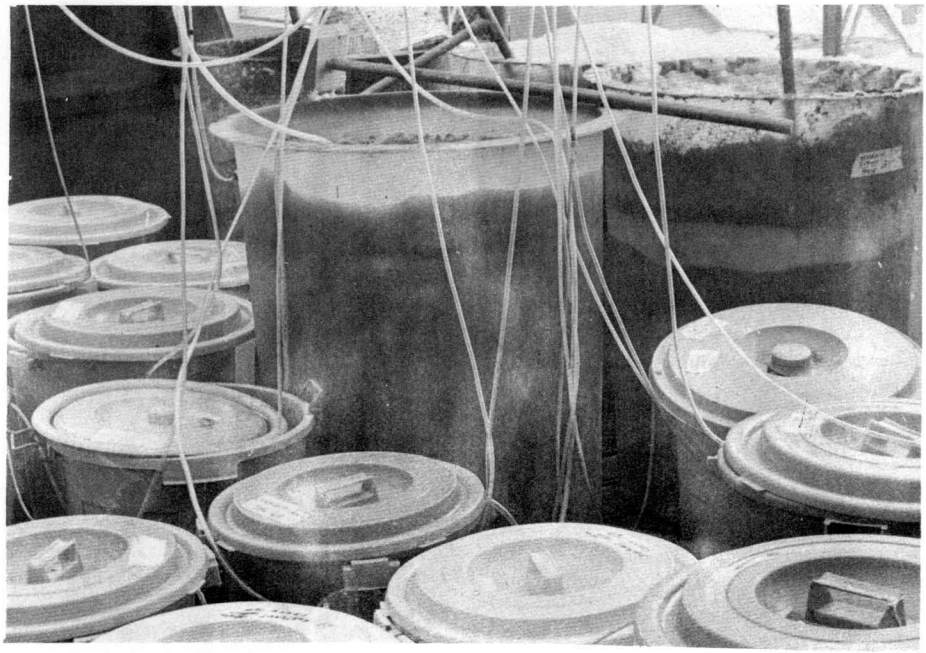
● POND CULTIVATION

Rearing operations in the pond have mostly suffered from low survival at harvest. Several studies on the use of suspension nets to acclimatize the larvae and to serve as nursery indicated that the hapa net as used for fish fry is not applicable to the prawn. Meanwhile feedback from fishpond cooperators also indicated the low survival rate of sugpo fry from the hatchery. This pointed out the need for a specially designed prawn nursery system to bridge the hatchery and the rearing ponds.

Based upon past experience, a list of desired attributes for a prawn nursery was drawn up, and on this basis the prawn nursery ponds system was designed. Briefly the following specifications for a prawn nursery were drawn up: 1) capability to regulate salinity, 2) facility to maintain dissolved oxygen concentration in the water



Supplementary feeds given to prawns in Leganes ponds



Fermentation of ground kitchen refuse tried as larval feed.

at an acceptable level, 3) dispersal of wind-accumulated lablab throughout each compartment, 4) efficient exclusion of predators, 5) efficient retrieval of juveniles, 6) ability to hold water at desired depth.

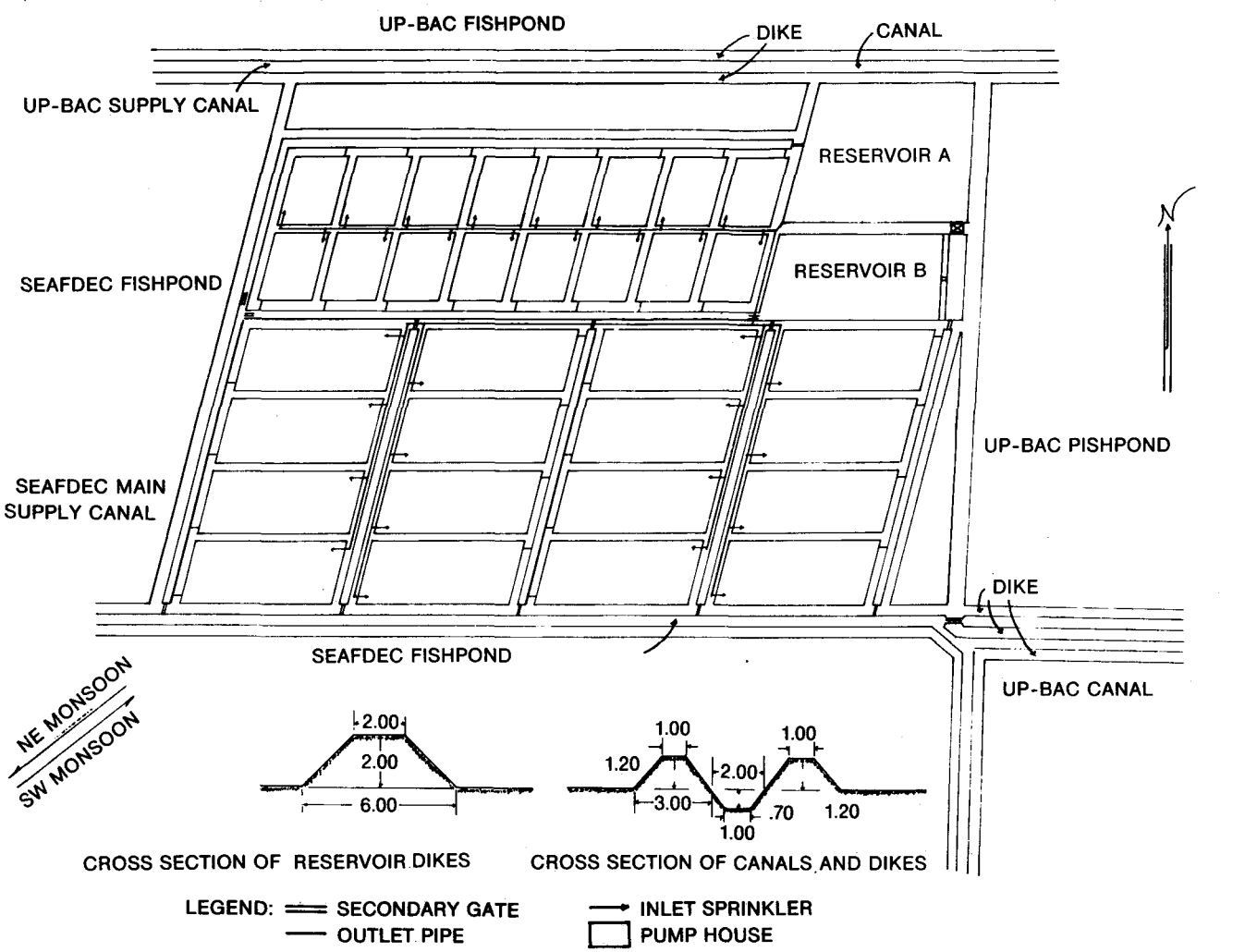
With the desired attributes in mind, the prawn nursery system was designed, Fig. 13. The rhomboid compartments are oriented with the longest diagonal along the major wind direction, NE-SW. This way lablab will be accumulated at the acute corners of the pond, where the water inflow-outflows are located.

Two reservoirs, one to hold normal salinity (32-34$^0/_{00}$) and the other to hold low salinity water, will make possible a flow-through system using PVC pipes. Pumps shall maintain the water of the reservoirs at the desired level.

The nursery shall occupy an area of 1.3 hectares, consisting of 3,000 sq m reservoirs and 32 nursery compartments of two sizes, 200 sq m and 500 sq m. The target stocking rate is 100 postlarvae per sq m. We expect to have a survival rate of about 50% after a 30 day rearing period using only lab-lab as feed. With this target stocking density and survival rate, the nursery will be capable of absorbing one million fry and yielding half a million juveniles every 45 days, out of which 15 days shall be needed for pond preparation. We intend to have the nursery operational by the second quarter of 1978.

Meanwhile plans are also being prepared for the construction of several small (200-500 sq m) ponds for experiments in pond cultivation. Research activities have been hampered by the lack of experimental ponds. All existing ponds are designed either as production or demonstration ponds which are too expensive to run for experiments, and also do not allow running replicates using several treatments at one time.

Fig. 13. Prawn nursery system



PROFILE OF SEAFDEC COOPERATORS

The target sector for the transfer of technology are the fish farmers. To systematize the transfer by intensifying training and extension work, we strengthened existing linkages with BFAR and Western Visayas Federation of Fish Farm Producers started in 1974 for the establishment of a Cooperators Program.

The Cooperators Program is a research-production scheme for studies on pond management and cultivation techniques utilizing the private sector. Under the scheme, we give sugpo fry free as research materials to pond owners who have undergone training as cooperators.

As of December 1976, a total of 48 cooperators had been involved in the Program. All the cooperators had formal education, with an average number of 14.7 years spent in school or the equivalent of a college level education. Only two had formal schooling in fisheries and one in agriculture, the rest were in law, medicine, engineering, commerce, and other disciplines. Their lack of training in fisheries was compensated by the length of their experience in the fishpond business. Almost all had experience in bangos culture averaging 12 years. Only 11 cooperators had experience in sugpo culture, averaging to two years. The pond holdings of the cooperators range from five to more than 300 hectares with an average of 67.5 hectares per cooperator.

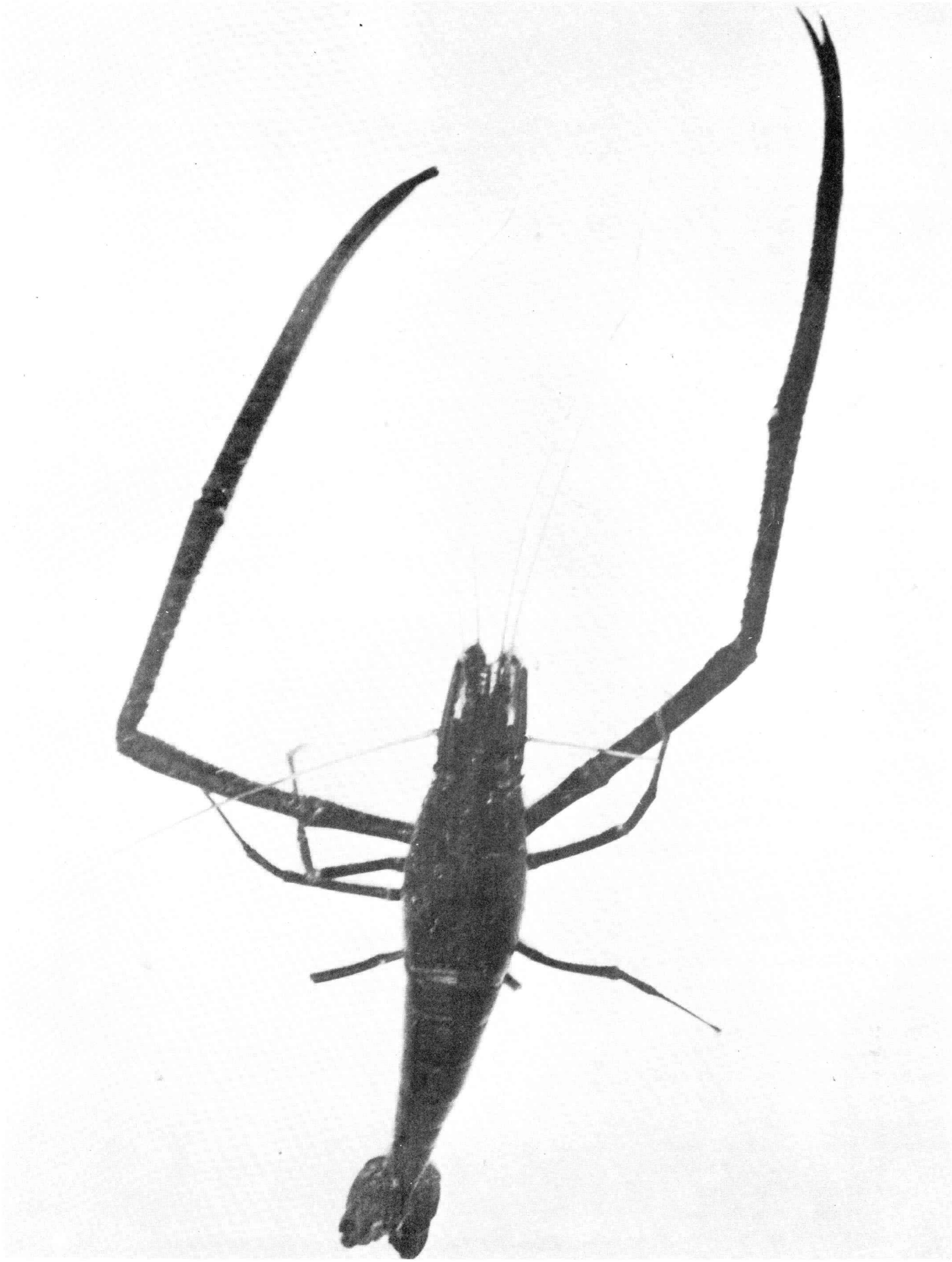
Ponds used by the cooperators in our study were previously devoted to bangos culture. Only 1-2 hectares of pond area were required of each cooperator for the study. The renovations made were repair of dikes and gates, pest and predator control, and soil preparation for feed growth.

In order to determine the factors that affect the growth and survival of sugpo in ponds, we regularly monitored such physico-chemical parameters as temperature, depth, turbidity, salinity, dissolved oxygen, pH and alkalinity. Daily weather conditions were also noted.

In the two-year period, we distributed a total of 1,465,000 sugpo fry to cooperators. Culture period ranged from 5 months to one year. Initial survival rates ranged from 0 to 63%. We noted that one of the reasons for low survival was the existence of predators. In spite of chemical and other means, predators still managed to enter ponds during culture, either as eggs or larvae. In some cases, pond soil was not analyzed and treated which also contributed to low productivity.

All the cooperators relied on *lablab* as natural feed, although some used animal meat as supplementary feed according to availability.

P. monodon *fry for transport by air to cooperators*



Giant freshwater prawn (Macrobrachium rosenbergii)

FRESHWATER FISHERIES PROGRAM

Research Highlights

The Freshwater Aquaculture Station became operational last year. We conducted research projects on various freshwater species, analysis of the lake ecosystem and other supportive studies.

Kanduli *(Arius* sp.) was raised successfully under laboratory conditions and results indicate the possibility of mass producing the species. Maturation experiments for eventual broodstock development were also conducted.

We also conducted experiments on diets and feeding. Three different diets were tried on catfish, or hito *(Clarias macrocephalus)* fry. Hito fry fed with *Moina macrocopa* had a higher average growth rate than those fed with zooplankton and ground freshwater shrimp.

Several trials on the effects of feeds and feeding rates on the larval stages of mudfish or dalag *(Ophiocephalus striatus)* were also carried out.

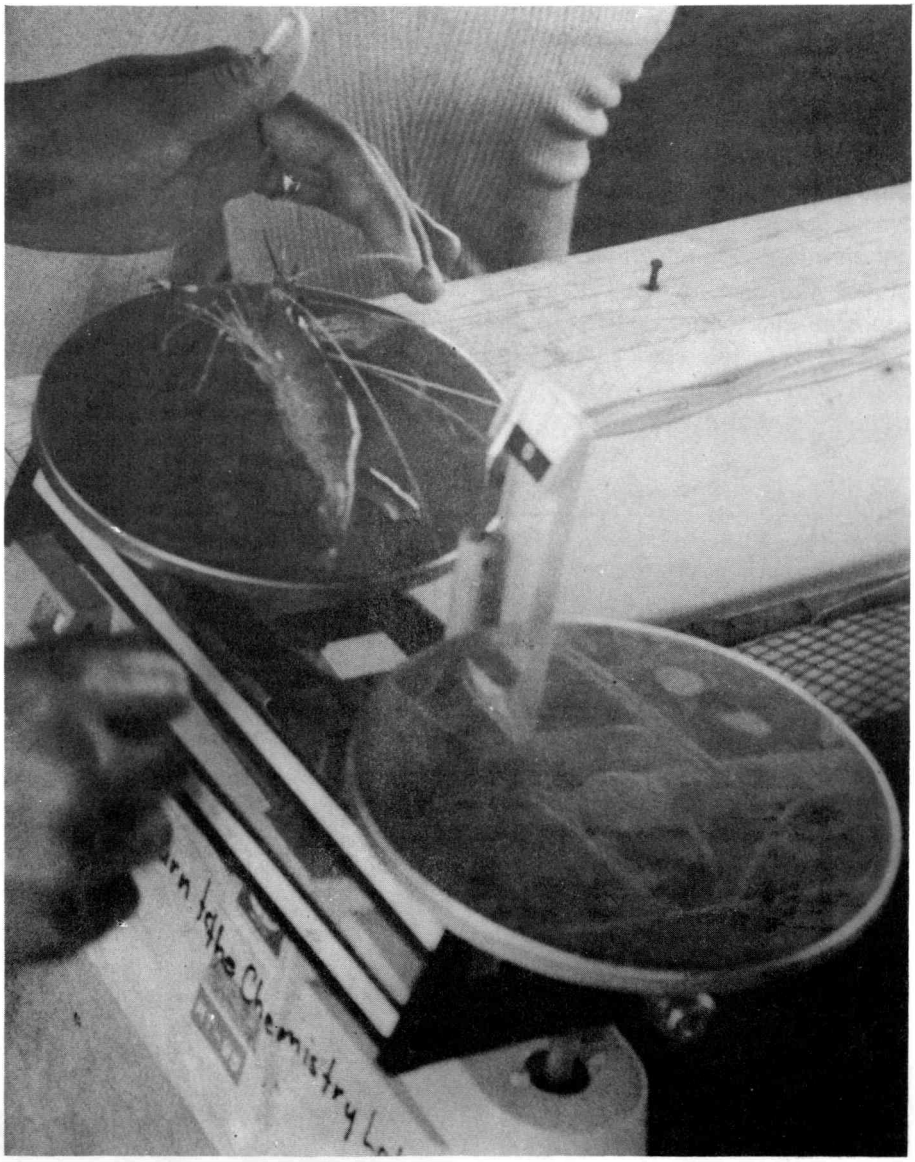
The Station implemented interrelated projects to describe the lake ecosystem, using Laguna de Bay as a model. Limnological conditions of the lake were assessed. A socio-economic study of small-scale fishpen aquaculture was started.

Various supportive experiments were conducted on the biology of freshwater snail *(Cipangopaludina lanaoensis),* and biodeposition rates of the freshwater clam or tulla *(Corbicula manilensis).*

Sugpo was found to tolerate a wide range of salinities. Experiments to acclimatize sugpo in freshwater conditions indicate the possibility of culturing them in a freshwater body like Laguna de Bay.

One of the problems in catfish culture is proper care, from the fry to fingerling stage. Experiments were conducted on the effect of different feeds for the growth and survival of fry.

Hito fry fed with *Moina macrocopa* showed a monthly average increase of 3.5 cm in length and 0.5 g in weight, while those fed with zooplankton and ground freshwater shrimps had a monthly increase averaging 2.0 cm and 0.1 g.



Spent spawner of M. rosenbergii *being weighed for fecundity studies*

The different stocking densities of hito fry were compared in order to determine optimum production per unit volume of water (Table 20).

Feeding Experiments

Selected species of freshwater algae were cultured with the use of various synthetic and organic media. *Chlorella ellipsoidea* and *Scenedesmus* sp., selected for their high protein content, were cultured as potential feed for the larvae and fry of bangos and dalag.

Acclimatization of the marine form of *Chaetoceros calcitrans* to the freshwater environment was explored by growing the alga at different salinity levels.

Vegetative filaments of the blue-green alga *Cladophora* sp. were subjected to gradual dessication using infrared light to induce the development of sexual reproductive spores. This method may provide the seed which could germinate and proliferate in fishponds and pens.

Limnological Conditions of Laguna de Bay

We have selected 12 sampling stations for monitoring physical, chemical, and biological parameters of Laguna de Bay. The ecological variables being monitored are DO, H_2S, temperature, free CO_2, alkalinity, HCO_3, CO_3, OH, pH, chlorides; EDTA hardness, air temperature, barometric pressure, and humidity. Bottom sediments from each sampling station are collected for macro, micro, meiobenthic studies. This study is important in view of the recurrence of fish kills in the lake.

Biology of Freshwater Snail

Molluscs, especially the freshwater snail *Cipangopaludina lanaoensis* make up most of the feeds for domestic ducks raised in Laguna de Bay. During certain months, the diet of kanduli is 76% mollusc. To a large extent, dalag and hito are also dependent on these snails for their food.

Initial studies indicate that a gravid freshwater snail produces on the average, one offspring a day. Higher reproductive rates were obtained in snails fed with camote leaves and mud compared to those fed with *chlorella* and *Scenedesmus,* which failed to reproduce even after two days. Further observations indicate that over-crowding and foul media prevent the growth of snails.

Biodeposition Rate of Freshwater Clam

Biodeposition rate of tulya *(Corbicula manilensis)* is measured by monitoring the amount of pseudofeces produced by *Chlorella*-fed experimental animals.

Physiology of a Freshwater Snail

Studies were conducted on the snail *Cipangopaludina* sp.

Snails, collected from the lake were used in respiration, excretion and calorimetric studies. Feces of snails were collected and dried in an oven. Calorimetric analyses were done by the Tests and Standard Laboratory of the National Institute of Science and Technology (NIST).

Table 20. Effects of Stocking Densities on the Survival of Hito Fry

Treatments	Stocking Rate (fry/m2)	Mortality (%)	Stocking Rate (fry/m2)	Mortality (%)
I				
II	3,600	74.0	700	18.3
III	2,400	52.0	525	18.3
	1,200	51.0	350	11.9

Taxonomy and Morphogenesis of Freshwater Algae

We took extensive collections of various freshwater algae in the lake. A total of 154 species belonging to 7 classes, 18 orders, 35 families and 70 genera were identified and described. Of these six are new varieties and 105 are recorded for the first time in the Philippines.

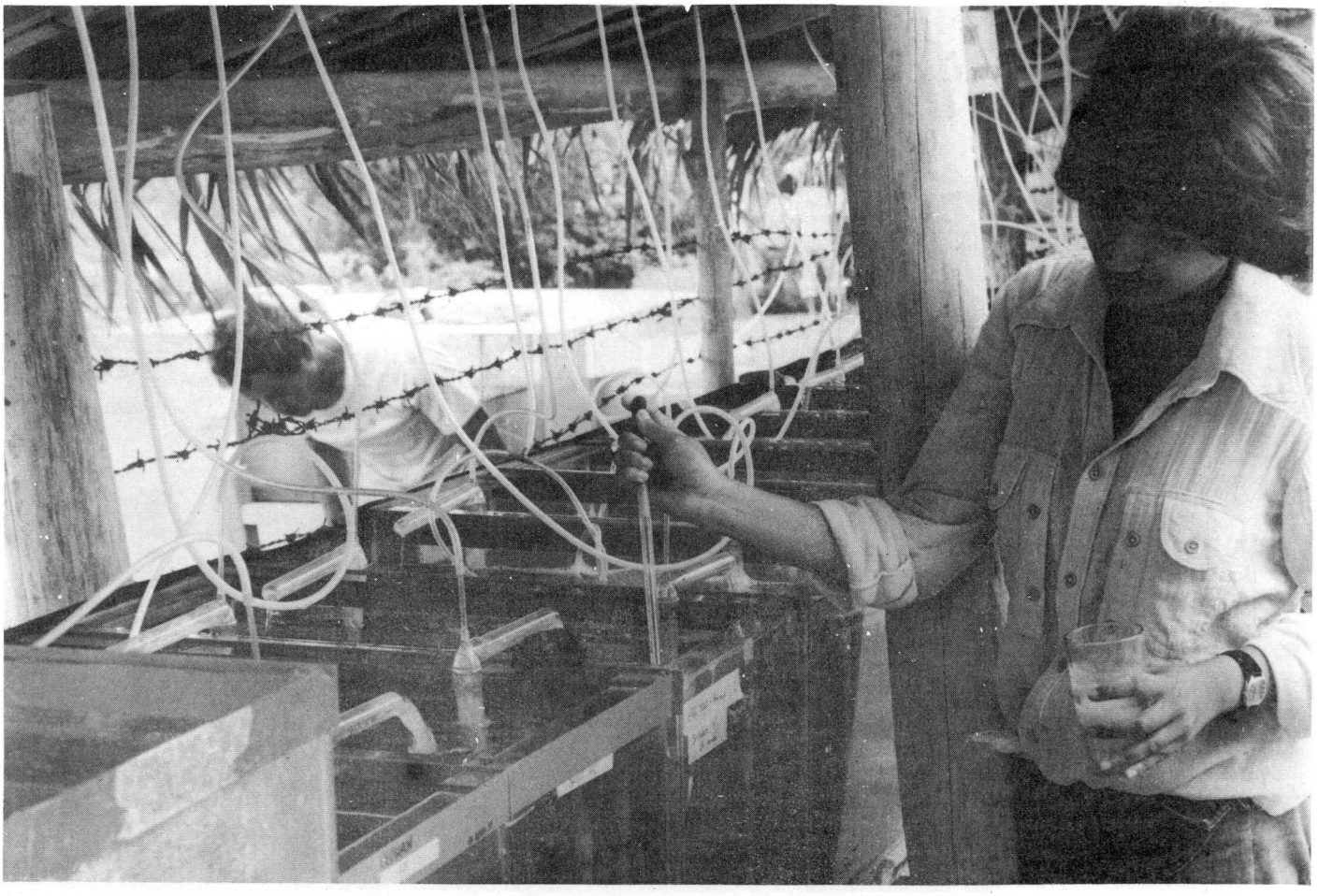
Observations show that *Cladophora* spp. predominated throughout the year except from the months of August to October. Their peak occurred from February to March. They formed densely entangled mats floating in the lake or attached to rocks. Other filamentous members of the Chlorophyta e.g. *Oedeogonium, Spirogyra* and *Stigeoclonium* occurred in smaller quantities. Motile unicells such as *Eudorina* formed dense blooms in September.

Diatoms consisting of *Navicula* sp., *Synedra ulna, Cymbella aspera* and *Sunirella splendida* were always present in the lake but in small quantities except during the colder months of December and January.

Members of the *Cyanophyta* were also found everywhere in the lake. *Microycystis aeruginosa* formed dense blooms from April to July. They were not present during August and September when typhoons were most prevalent but reappeared from October up to December. Nitrogen-fixers such as *Anabaena, Rivularia* and *Nostoc* occurred throughout the year in small amounts.

The nutrient requirements of *M. aeruginosa,* the species commonly associated with fish kills in Laguna de Bay, were determined. This species was highly responsive to nitrate-nitrogen enrichment and varying levels of phosphorus. Micro-nutrients were required for sustained growth. Furthermore, highly alkaline medium was preferred by the organisms.

Bioassay experiments on the possible toxicity of *M. aeruginosa* were conducted. Milkfish fingerlings died when fed with 50% dried *Microcystis.*



Larval rearing of M. rosenbergii *in aquaria*

Cluster of mussels is lifted for regular inspection

SEAFARMING PROGRAM

Activities in 1976

This program has two major components, namely: 1) broodstock development and culture of marine and estuarine finfish and shellfish at Igang station; and 2) the establishment of a pilot demonstration farm for viable seafarming projects at strategic centers in Mindanao and Sulu.

A mussel research project was initiated in September 1975 with assistance from the Government of New Zealand which contributed materials and expertise.

Experiments on the issue of cultivation of other molluscs such as oysters were also initiated. We hope to establish pilot mollusc farms in strategic areas.

Artificial breeding and propagation of some commercial finfish and shellfish are being tried in aquaria, cages and tanks at our Seafarming station in Zamboanga City.

A 10-hectare lagoon was established at Sta. Cruz Island Pequeño for the culture of siganids, mullet, milkfish, and shellfish. Test plots for mussel and oysters in Sangale and Rio-Hondo, Zamboanga City were constructed. Spats of the green mussel, *Mytilus smaragdinus* from Sapian Bay, Capiz and oysters, Crassostrea spp. from Bacoor Bay, Cavite were introduced. A survey of prospective hatchery sites for penaeid and *Macrobrachium* including source of spawners was undertaken in Zamboanga del Sur.

Tahong Farming

Two commercially important mussel species in the Philippines are the tahong or green mussel *(Mytilus smaragdinus)* and the more widespread brown mussel *Modiolus metcalfei.* The green mussel is already cultured in Bacoor Bay, Cavite and Sapian Bay, Capiz. The brown mussel on the other hand, is gathered from the wild. Through our seafarming program, we hope to determine the biology of these two species of mussel, study the feasibility of farming the brown mussel, and introduce innovative techniques of farming the green mussel.

Results of our preliminary surveys indicate that the Sapian River Mouth in Panay Island is a good site for green mussel farming. It is noted to be even better than Bacoor Bay because of the absence of industrial pollution.

The shallowness of Sapian River Mouth (Figure 12) makes it more useful as a seed collection area, but the growing of mussels has to be undertaken either in the deeper portions of the Bay or elsewhere. With the extremely high settlement density and limited growing surface, majority of the spats will have to be transplanted to deeper waters.

However, the techniques for transplanting mussel spats remain to be developed. We are now testing various materials to bind loose spats to growing ropes until attachment. A local material, specially woven sinamay strips made of abaca fiber, shows promise.

Experimental mussel farm, Himamaylan, Negros Occidental

Data obtained from six months of studies on the brown mussel indicate that the species has a very low aquaculture potential. No *Modiolus* spat was found to settle on any of four types of substrate tested: black fibrillated polypropylene film, black film rope, blue polypropylene fiber rope and coir rope. The brown mussel in nature forms a dense mat on the mud bottom of shallow bays. It was never found attached to bamboo structures commonly found in Philippine bays. *Modiolus* spats were found to attach only to living adult mussel Attempts to use empty shells strung on rope were unsuccessful — the shells were too brittle.

For green mussels, black fibrillated polypropylene film, black film rope and coir are almost equally attractive as spat collector. The blue polypropylene fiber rope had a consistently low spat settlement during the study period. However, coconut husk was found to be an extremely good spat collecting material.

Growth rate averages 10 mm increase in length per month. A two meter length of rope yielded 20 kg of tahong (whole weight) after five months.

Surveys of the Panay-Negros area show the occurrence of the green mussel in Himamaylan and Himigaras Rivers, Negros Occidental. Since tahong farming was already established in Sapian at the time we conducted the biological studies, we felt that putting up a pilot demonstration farm employing better farming techniques would duplicate existing operations in the area. Instead, we decided to establish a pilot demonstration farm at Himamaylan River, Negros Occidental.

Sampling for mussel larvae at Himamaylan

Here, SEAFDEC already maintains a substation for sugpo spawner collections. The Himamaylan project will serve as a shallow water farm and seed collection center. A deep water (5 m) farm using a buoy and long line system will later be established when a suitable site has been determined. Spats collected from Himamaylan will be used to stock the deep water farm.

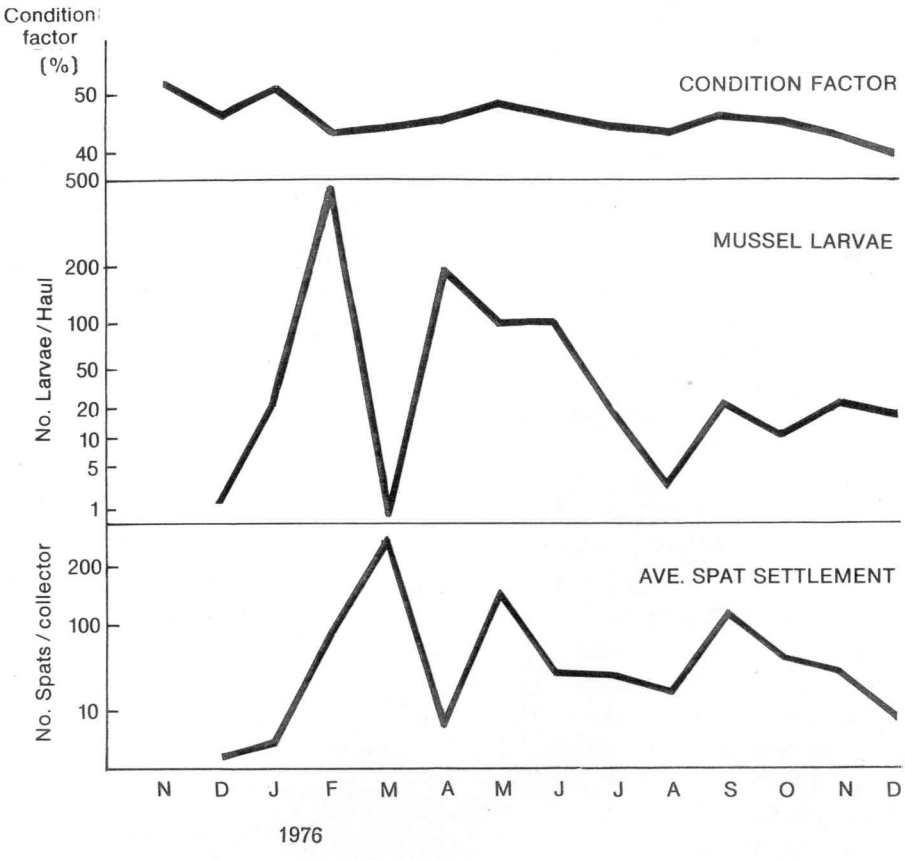
Biology of the Green Mussel

Data on the seasonal changes of the condition index, larval occurrence and settlement numbers agree with each other in indicating an early February spawning in 1976 (Figure 14). This spawning is, however, not shown by the gonad sections which indicate a late December and early April spawning (Table 21). The December spawning is reflected by the condition index

Table 21. Gonad condition frequency (From November 7, 1975 to April 7, 1976)

Sampling Date	Total No. Examined	Stages I M	I F	II M	II F	III M	III F	IV M	IV F	V M	V F	Gonadal condition of modal stage
11/7/75	27			3	3	5		4	9		3	Ripe
11/27/75	12			1	1	5	1	2	2			Ripe
12/9/75	10	2	1	2	2	1	1				1	Advanced gametogenesis
12/18/75	12	4		1		1		3		1	2	Spawned out to regeneration stage
1/8/76	10	6	1			2	1					Redeveloping
1/22/76	9			4				3	1	1		Advanced gametogenesis
2/5/76	11	1	1	1		4	2				2	Ripening
2/25/76	9			1	4	1	1				2	Advanced gametogenesis to ripening
3/9/76	9	1						5		3		Ripe
3/24/76	9					2		2	5			Ripe
4/7/76	9							2		3	4	Spawned

Fig. 14. Relationship between spawning (as indicated by condition index) larval occurrence and settlement



but not by the settlement data, while the April spawning is reflected by both types of data. The discrepancies could be due to the fact that the mussels do not spawn at the same time, patchiness of the larval distribution, and sampling variability, these factors either singly or in combination with each other. A time lag of at least two weeks between possible spawning time and spat settlement indicated a planktonic larval life of approximately two weeks.

Post-Harvest Handling of Tahong

It is necessary for mussels to reach the consumer live. Harvests from the mussel farms in Sapian Bay are now air freighted to Manila at considerable cost. It is therefore important to find ways of prolonging their life after harvest in order to be capable of getting the mussels to the market live and with minimum losses. An experiment showed that large mussels are hardier than small ones (Table 22). It was also found out that differences in mortality with size are not consistent with handling.

Keeping the tahong wet with seawater regularly appears to be one way of improving their survival rate after harvest (Table 23).

Biology and Culture of Finfish and Shellfish

During the year, the Department conducted experimental cultivation of *Scylla serrata*, *Neptunus* spp. *Ranina dentata* and other commercial crustaceans in tanks, cages and aquaria. Pilot cultivation of natural fry in cages, pens and tanks was also undertaken in the same year. The domestication, spawning and cultivation of *Siganus* spp., *Lates calcarifer*, *Lutjanus* spp., *Epinephelus* spp. were also started.

Table 22. Mortality of Tahong due to Handling [1/] (Initial number of mussels was 100, experiment time was 48 hours)

	Large (6C-83)	Medium (40-60)	Small (28-38)	Tiny (16-28)	Total
A.	45	44	65	70	
	47	63	79	82	
	92	107	144	152	495
B.	46	68	81	80	
	35	65	63	75	
	81	133	144	155	513
Total	173	240	288	307	1,008

Source of variation	d.f.	S.S.	M.S.	F
Treatment	7	2878		
Handling	1	20.25	45.25	0.274
Sizes	33	24736.70	8,245.57	111.43**
Interaction	3	21,878.95	7,292.98	98.55**
Error	8	,592	7 74	

**Significant at $P<0.01$.

1/ Handling consists of:
A. Dead tahong counted and removed every six hours; and
B. Dead tahong counted only after 48 hours.

Table 23. Survival of Mussel after Harvest [1/]

A. After 48 hours

First trial

	Control	Wet	Total
Dead	50	19	69
Alive	55	90	145
Total	105	109	214
% dead	47.62	$ 17.43	

$x^2 = 17.623$ $P < 0.005$

Second trial

	Control	Wet	Total
Dead	56	22	78
Alive	56	80	136
Total	112	102	214
% dead	50.00	21.57	

$x^2 = 14.01$ $P < 0.005$

B. After 60 hours

First trial

	Control	Wet	Total
Dead	100	75	175
Alive	12	34	46
Total	12	109	221
% dead	89.9	68.8	

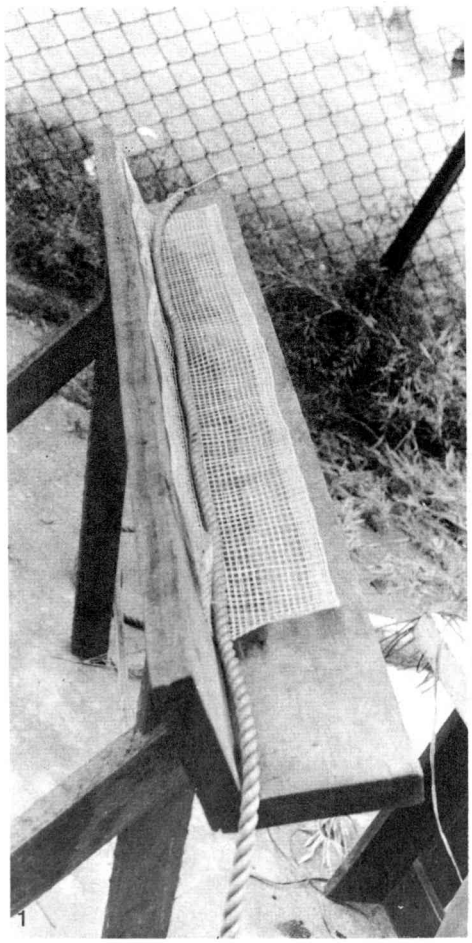
$x^2 = 12.47$ $P < 0.005$

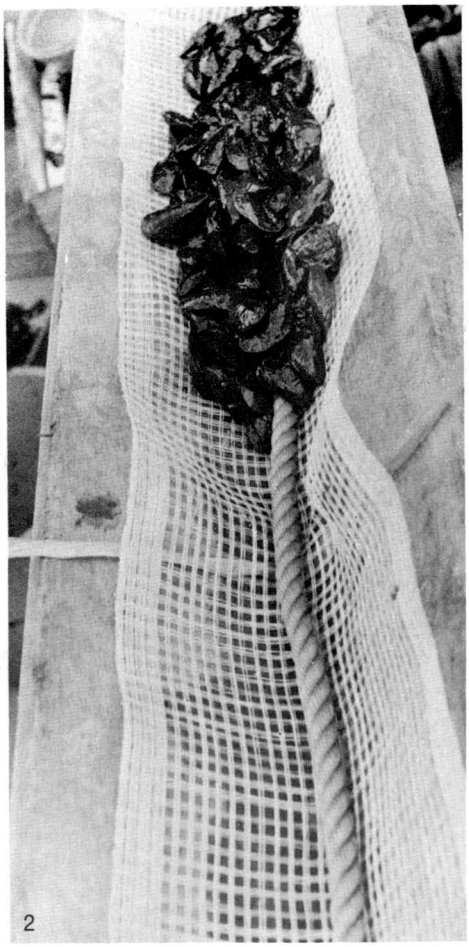
Second trial

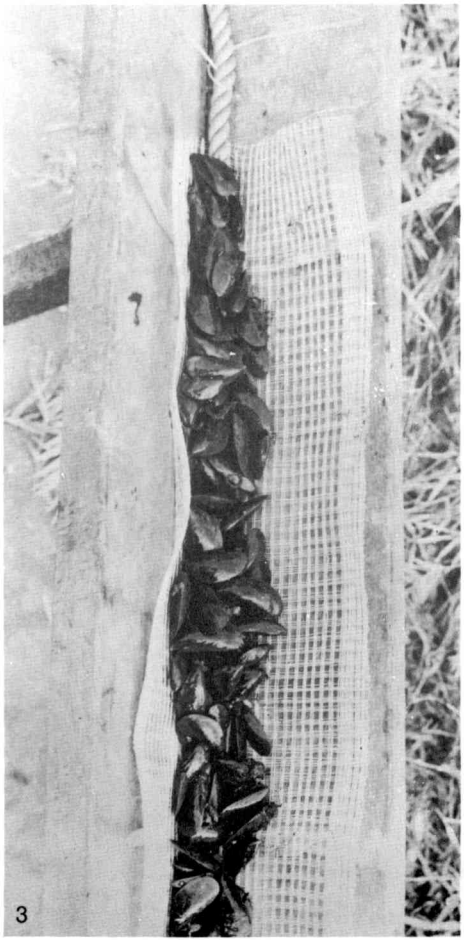
	Control	Wet	Total
Dead	102	72	174
Alive	3	72	33
Total	105	102	207
% dead	97.1	70.6	

$x^2 = 14.497$ $P < 0.005$

1/ The sacks of tahong were placed inside styrofoam boxes. The experimental group were soaked in sea water for about one minute each time.







1. *Strip of specially-woven abaca netting and wooden trough used for binding mussel spats to growing rope*

2.&3. *Mussel spats are laid on abaca netting for binding*

4. *Mussel spats bound to growing rope*

Harvesting of milkfish

SOCIO ECONOMIC ASPECTS OF AQUACULTURE INDUSTRY

All the research being undertaken by the Department seeks not to stimulate curiosity, but to improve the technology as well as lifestyle of people in the fishing industry.

To give us a better idea of how our work could influence people, we commissioned the Philippine Council for Agriculture and Resources Research (PCARR), as an initial effort, to study the socio-economic aspects of the aquaculture industry in the Philippines.

The industry is made up of fry gatherers and concessionaires, nursery pond operators, and fishpond/fishpen operators.

In 1975, PCARR completed a socio-economic study on fry-gatherers. Last year, it gathered and assessed data on the cultural practices employed by fry concessionaires and pond operators. For the coming year, the PCARR plans to conduct studies on existing marketing structures and distribution channels.

The survey on fry gatherers covered those who handled bangos, prawn, oysters, mussels, seaweeds, eel, tilapia and hito. The sample consisted of 2,459 gatherers, concessionaires, operators and seafarmers.

The survey gave us information on the characteristics of fry gatherers, seasonal patterns in fry gathering, economic gains derived from the trade, including marketing problems such as inadequate storage and fluctuating prices.

Concessionaires and dealers play a prominent role in the collection of fry and their transfer from fry grounds to fishponds and pens. On the average, concessionaires spend 6.9 months collecting fry and 3.6 months in other occupations. The rest of the year, they are idle.

Most of the concessionaires handle various fry species which are gathered from seashores, estuaries, and river mouths. Most of them use particular methods for fry gathering. They obtain their concessions by open or sealed bidding through municipal or city governments or by directly obtaining municipal permits.

Fry are counted with the use of pebbies or similar instruments, tally sheets, or by rough estimates through ocular inspection. Stored fry are kept in basins, earthen pots and styrofoam boxes for an average of 5.3 days. These are sold by concessionaires to buyers who are found anywhere from 82 kilometers away in Luzon to 347 kilometers away in Mindanao.

As the supply of fry is seasonal, prices fluctuate from one month to another. For the country as a whole, the prices of bangos fry are low from May to July.

Through these studies, we were also able to identify areas where fry are gathered and cultivated throughout the Philippines.

Bangos Fishponds

The culture of milkfish or bangos provides direct employment to some 170,000 workers and laborers. According to the Bureau of Fisheries and Aquatic Resources, about 176,000 hectares of operating fishponds and 529,000 hectares of swamplands are available for development.

The average annual production of bangos is about 600 kilograms per hectare. Techniques have been developed to increase the output from 600 to about 2,000 kilograms per hectare per year.

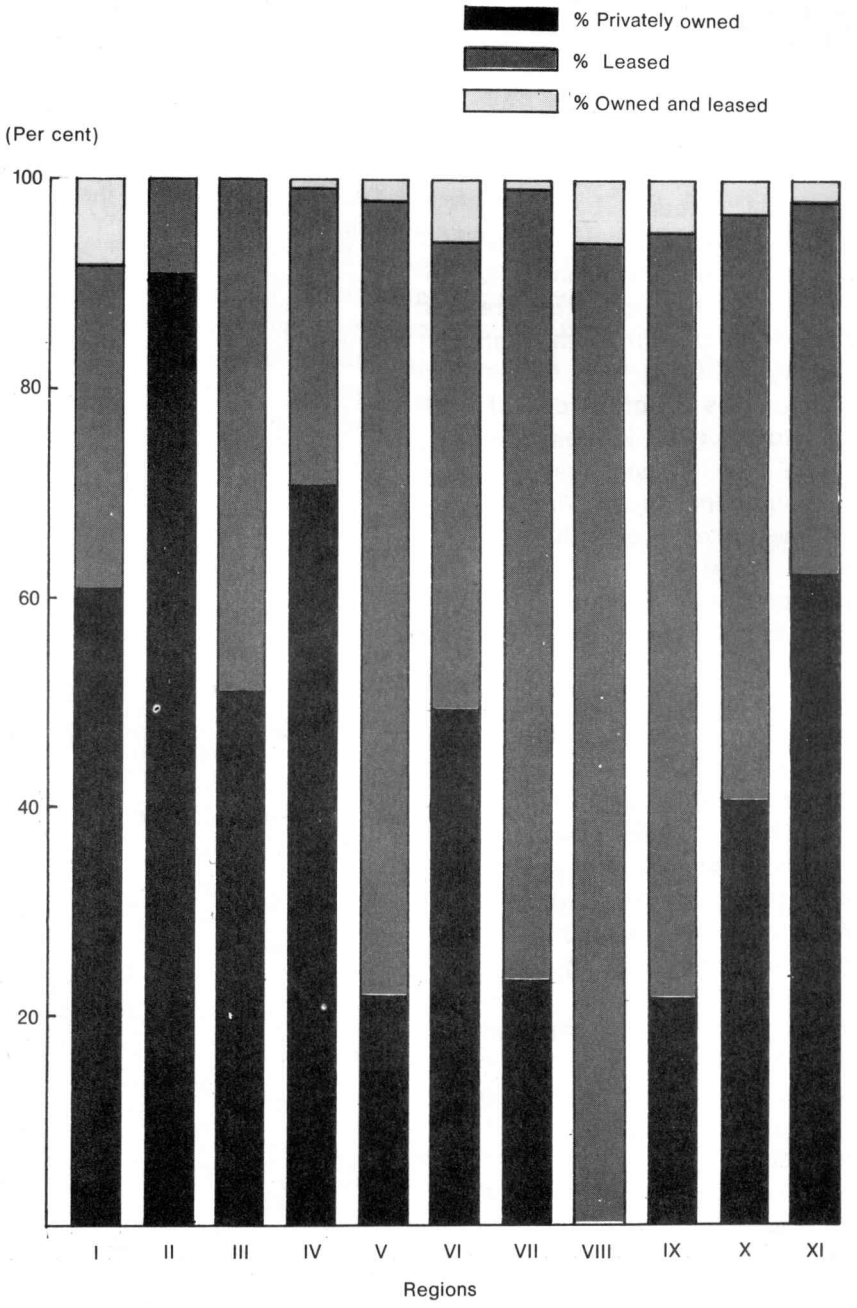
Pond owners and caretakers are active almost all year round. They spend around seven months in fishpond operations, four months in other occupations, and are idle for only one month.

Most fishpond owners have 17 years of experience in the industry, compared to 14 years for caretakers. The fishponds are either owned or leased (Figure 15). Areas range from 4.9 hectares in Ilocos to 41 hectares in Western Mindanao, or an average of 16 hectares for the country as a whole. The average operational area per farm for the Philippines is 13.39 hectares of which 11.32 hectares are used for rearing, 1.41 hectares as transition ponds, 0.59 hectares as nursery ponds, and 0.07 as catching ponds (Table 24).

General repair, cleaning, drying and levelling of bottom are among the various aspects of pond preparation, which take about four weeks.

The operators reported that predators and pests like bid-bid, buwan-buwan and tilapia are found in their ponds. To eradicate these pests, the following methods are used: 1) chemical

Fig. 15. Type of ownership of bangos fishpond



method, 2) catch-and-kill method, and 3) pond drying method.

Pesticides used are Brestan, Gusathion, Aquatin, Thiodan and tobacco dust. The average number of days spent for pond treatment using common pesticides range from eight days for Gusathion to 12 days for tobacco dust.

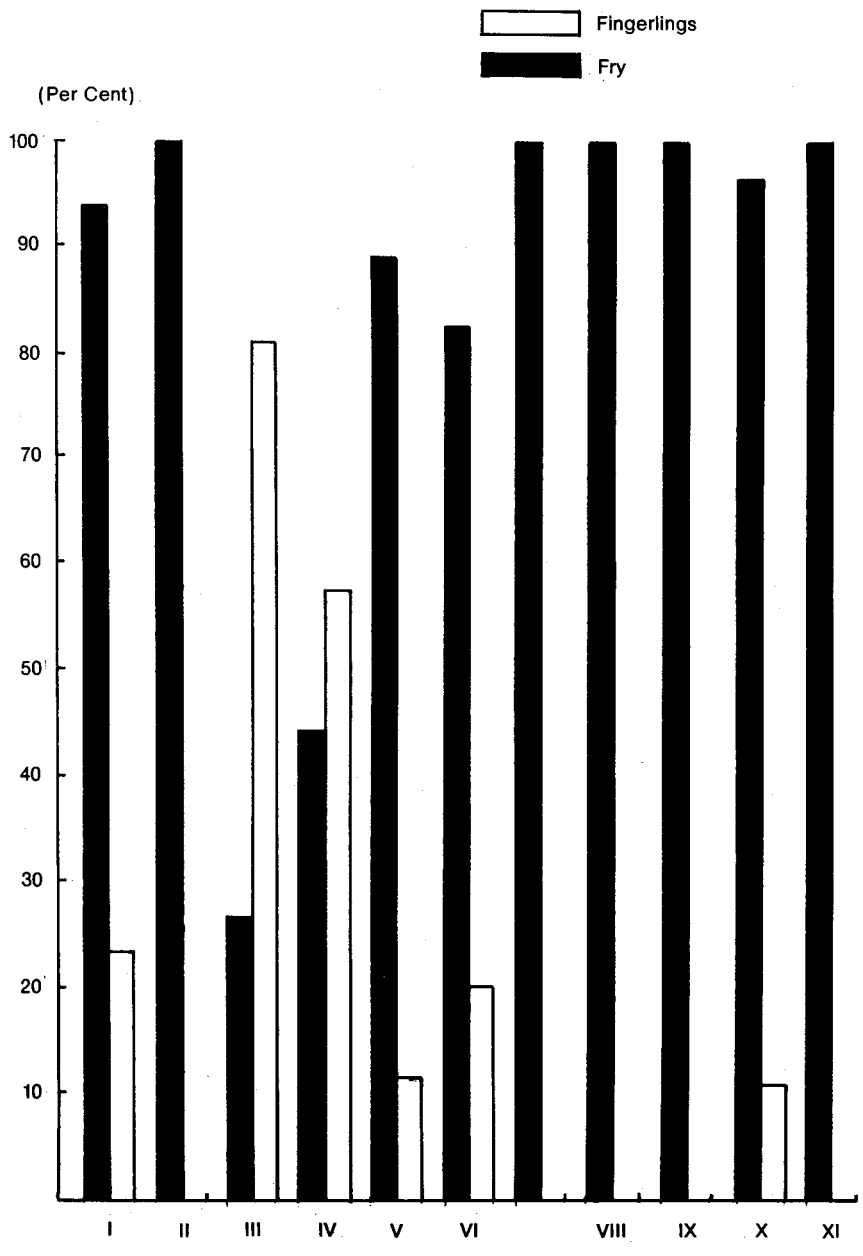
Pond fertilization is practised by two-thirds of the sampled operators. Organic fertilizers such as chicken dung and animal manure are commonly used at the rate of 31.3 sacks per hectare.

The operators maintain an average of 19 cm pond water level during feed growth. When natural food is insufficient, supplementary feeding consists

Table 24. Area of various types of ponds in bangos fishponds (Pond area is in hectares per farm)

Region	Number of farms	Nursery ponds	Transition ponds	Rearing ponds	Catching ponds	Total
I	267	0.29	0.64	3.26	0.03	4.22
I II	11	0.36	0.29	9.47	0.15	10.27
III	304	1.00	2.29	17.13	0.07	20.49
IV	119	0.32	0.60	4.82	0.06	5.80
V	53	0.43	0.96	9.45	0.14	10.97
VI	184	0.78	2.42	12.98	0.15	16.33
VII	87	0.24	0.33	0.33	5.23	5.82
VIII	16	0.79	2.54	32.44	0.24	36.01
IX	42	0.47	1.18	16.98	0.06	18.69
X	38	0.42	0.94	37.47	0.09	38.92
XI	54	0.41	1.24	10.15	0.04	11.84
Philippines	1,175	0.59	1.41	11.32	0.07	13.39

Fig. 16. Type of stock used



of rice bran and bread crumbs.

Seventy per cent of the operators stock their ponds with fry instead of fingerlings (Figure 16). Operators from Central and Southern Luzon, however, stock their ponds with fingerlings once a year.

Purchasing and stocking in large quantities for rearing are practised to take advantage of the abundance of fry and fingerlings at periods when prices are low. The average quantity of stock purchased is 62,000 fry and 32,000 fingerlings per pond (Table 25), which are either picked up or delivered within an average distance of 81 kilometers. The means of transport used are land vehicles, banca and motor boat. However, hand carrying of stock is most common in Southern Mindanao.

The average mortality of fry during shipment ranges from 6 to 24%. During rearing, the stock is further reduced by about 34%. The average mortality rate of the fry from the source to harvesting is 45%, the highest being 74% and the lowest 26%. Average mortality rate of fingerlings during shipment is 13%. However, their chances of survival during rearing are greater. This gives an average mortality rate of 39% for fingerlings from the source to harvesting (Table 26).

Harvesting of stock is determined by the size of the fish. Other factors influencing harvesting include depletion of natural food in the ponds, approaching typhoon, need for cash, and changes in water conditions. Total harvesting is commonly employed, although selective harvesting is popular in Western Mindanao. In almost all cases, pond draining is employed. Other common methods used are gill netting in Central and Southern Luzon, and Bicol; baklad in Ilocos; and pasubang in Cagayan Valley, Western and Northern Mindanao.

Some of the very common problems encountered by the fishpond operators are lack of credit assistance, fluctuating prices of inputs and output, lack of technical support from field technicians, and lack of government programs for increased production.

Fishpen Aquaculture

Fishpen aquaculture is widely practised in Laguna de Bay, the biggest lake in the country, which is capable of producing 1.5 to 4 metric tons of fish per hectare per year.

Fishpen size in Laguna de Bay ranges from 0.16 to 45 hectares with an average of 6.09 hectares. Pens in San Pablo are much smaller, ranging from 30 to 840 sq m or an average of 300 sq m. Pens are usually made out of bamboo and nets, or chicken wire Sixty-one per cent of fishpens in Laguna de Bay and all of those in San Pablo are managed as a single proprietorship; 22% and

Table 25. Quantity of stock purchased per farm per purchase (in thousand pieces)

REGION	NO. OF FRY	AVE. NO. OF FINGERLINGS
I	21	6
II	26	—
III	65	49
IV	79	5
V	17	13
VI	129	16
VII	19	—
VIII	65	—
IX	43	—
X	148	53
XI	198	—
Average for Philippines	61	32

Table 26. Average mortality rates of fry/fingerlings

	FRY				FINGERLING			
Region	No. of Farms	Purchase to Stocking	Stocking to Harvesting	Purchase to Harvesting	No. of Farms	Purchase to Stocking	Stocking to Harvesting	Purchase to Harvesting
I	252	6	39	45	64	11	33	44
II	11	7	33	40	—	—	—	—
III	75	20	22	42	242	15	24	39
IV	52	15	32	47	69	11	27	38
V	47	16	25	41	6	13	37	50
VI	152	7	26	33	36	11	20	31
VII	87	10	44	54	—	—	—	—
VIII	16	21	31	52	—	—	—	—
IX	41	6	41	47	1	8	35	43
X	32	7	37	44	7	6	43	49
XI	53	10	42	52	1	7	11	18
Philippines	808	11	34	45	426	13	26	39

17% are owned by partners and corporations, respectively.

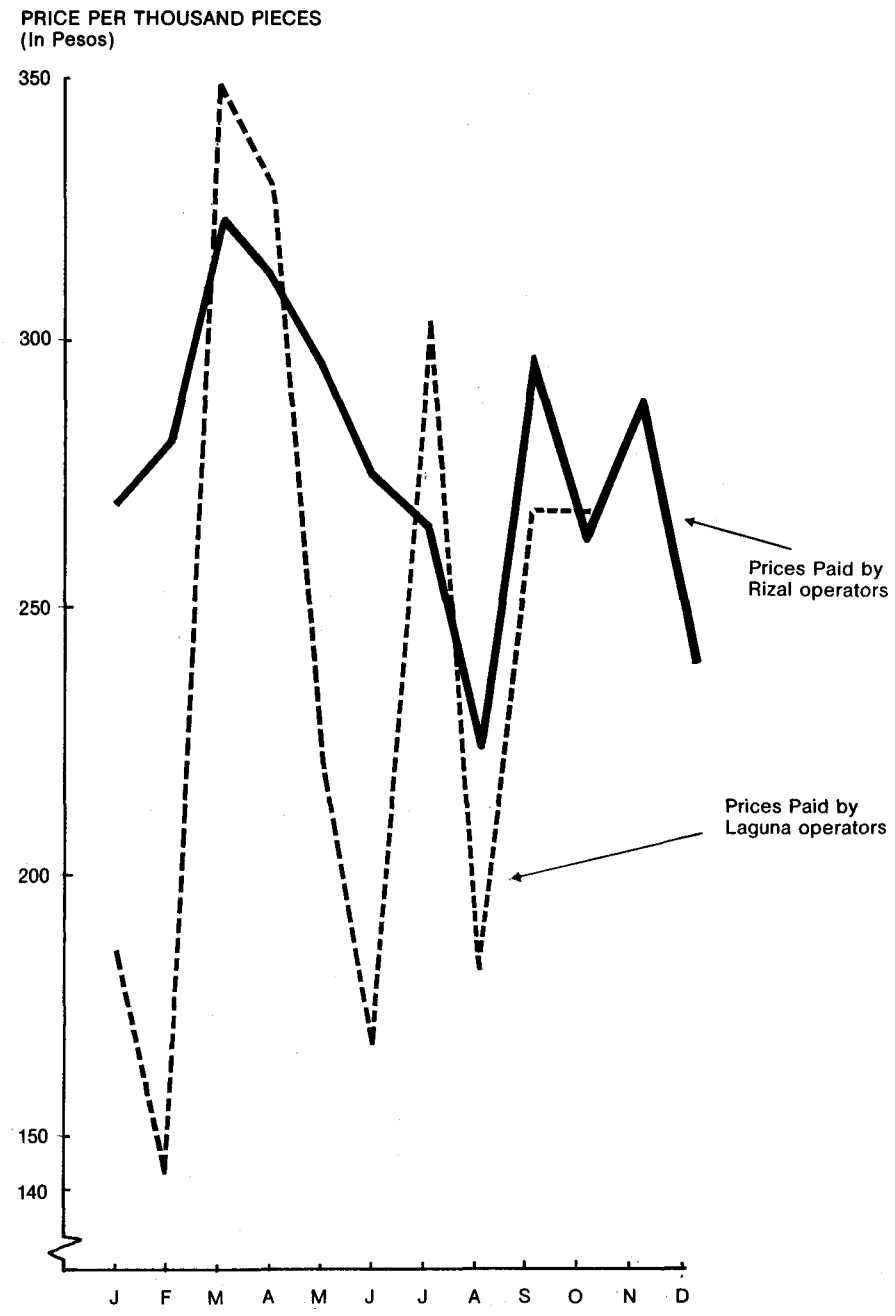
In Laguna de Bay, three-fourths of the operators leave their pens idle for a period of 15 weeks, usually from November to February. San Pablo operators, on the other hand, conduct continuous operation throughout the year because of the abundance of tilapia fry.

Fishpens in San Pablo lakes are stocked mainly with fry, while those in Laguna de Bay are stocked with fingerlings bought mostly from nearby towns and provinces. Operators from Rizal province purchase an average of 179 thousand pieces of fingerlings per pen. Those from Laguna purchase an average of 95 thousand pieces per pen. The stocks are transported in a large motorized banca or "pituya". Mortality rate of fingerlings from purchase to actual stocking ranges from 3.5 to 8.6 per cent.

Extensive stocking in Laguna de Bay is done from January tc May, the heaviest in May and the least in November and December. The annual stocking rate is about 24 thousand pieces per pen or 36 thousand pieces per hectare. Bangos fingerlings cost about ₱0.28 per piece (Figure 17). The price gradually increases in January reaching its highest in March. Then it slowly declines in August and abruptly increases again in September.

Rearing takes about six months from stocking to harvesting; the number of rearing period ranges only from one to two per year. The size of fish primarily determines the date of harvesting. Other factors that affect the time of harvesting are: demand for stock, weather conditions, and unavailability of natural food.

Fig. 17. Monthly prices paid for bangos fingerlings, 1974



Harvesting is intensive during the months of August to December. Operators from Rizal harvest their largest crop in August, while those from Laguna, in October. The average yield obtained is about 26 thousand pieces per pen or 13.6 thousand pieces per hectare, equivalent to 3,798 kg of bangos per hectare.

In San Pablo, cropping usually starts in September and lasts until December with an average yield of 347 kg per pen.

On an annual basis, a fishpen in Laguna de Bay earns a net cash income of ₱29,500 or ₱4,150 per hectare to ₱22,150 per pen or ₱3,450 per hectare (Table 27). Fishpen operators in San Pablo, on the other hand, derive an income of ₱1,300 from each pen per year.

Problems encountered by the fishpen operators are: insufficient technical support from the government; irregularity of the supply of fingerlings; and fluctuating prices of the stocks.

Table 27. Cost and returns per pen/per hectare (in pesos)

Item	Lake Laguna de Bay				San Pablo
	Rizal		Laguna		lakes
	Per pen	Per hectare	Per pen	Per hectare	Per pen
Farm Receipts:					
Cash	134,296	20,246	70,072	12,255	1,753
Non-cash	1,043	157	1,354	237	435
Total receipts	135,339	20,403	71,426	12,492	2,188
Farm Expenses:					
Cash	94,115	14,188	57,229	10,010	452
Non-cash	6,553	989	4,563	799	442
Total expenses	100,668	15,177	61,792	10,809	894
Net Cash Farm Income:	40,181	6,058	12,843	2,245	1,301
Net Non-Cash Farm Earnings:	(-5,510)	(-832)	(-3,209)	(-562)	(-7)
Net Farm Earnings	34,671	5,226 22	9,634	1,683	1,294

Table 28. Number of man-days required per mussel farm

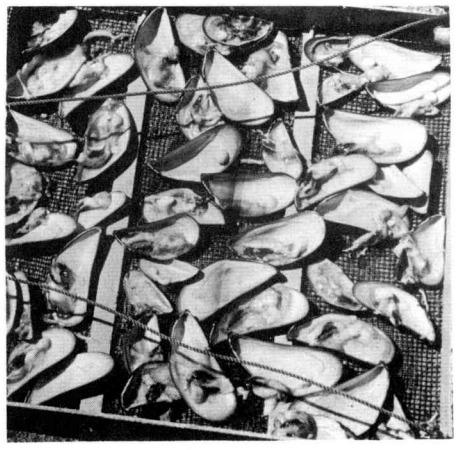
	For 600 sq m and below	For 601 sq m and above	Average per operator
Plot lay-out	0.46	5.75	1.78
Cultches preparation	8.90	7.12	8.01
Setting of cultches	8.00	8.89	8.45
Guarding	13.48	28.16	21.07
Harvesting	24.12	26.04	25.08
Sorting	—	2.88	2.88
TOTAL	53.78	71.17	62.47

Mussel Farms in Bacoor Bay

Tahong *(Mytilus smaragdinus)*, the most common mussel in the Philippines, is cultivated in Bacoor Bay, Cavite. Other potential areas for cultivation are Tinagong Dagat, Capiz; Calauag Bay, Quezon; and Maqueda Bay, Samar;

Tahong farms require very little labor with small farms requiring 54 man-days from plot layout to harvesting, and 71 man-days for large farms (Table 28). Operators of small farms devote 20 man-days on the farm or an equivalent of 8 days, while those in large farms spend 34 man-days. Only large farms reported the use of family labor which contributes 24 man-days for the industry.

Tahong may be harvested by diving or "sisid" method six months after the stakes are placed. These are done by hired laborers paid ₱6.00 per day. Peak months of harvesting are November and December when most farms harvest an average of 2,286 and 1,917 cans, respectively (Table 29). Price of tahong in December was lowest, at ₱2.42 per can (Figure 18).



Fresh mussel for P. monodon *broodstock on feeding tray*

On the average, a total of 1,330 cans of tahong are produced per farm, 98% of which are sold in cash. A small portion, about 2.4% of the total production, is either consumed or given away (Table 30).

Gross income per tahong farm amounts to ₱4,634 while expenses are ₱2,059. Net cash income amounts to ₱2,361 per year (Table 31). Gross income consists of cash and non-cash receipts. Cash receipts involve the value of the tahong sold, while non-cash receipts include the value of tahong used for home consumption or those given to friends.

Expenses include cash spent on the farm like bamboos, hired labor, fees for fuel and oil, permits and others. Non-cash farm expenses include unpaid family labor and depreciation.

Ninety per cent of the respondents own their houses, 3% pay rent, while 7% live

Fig. 18. Average monthly price of tahong

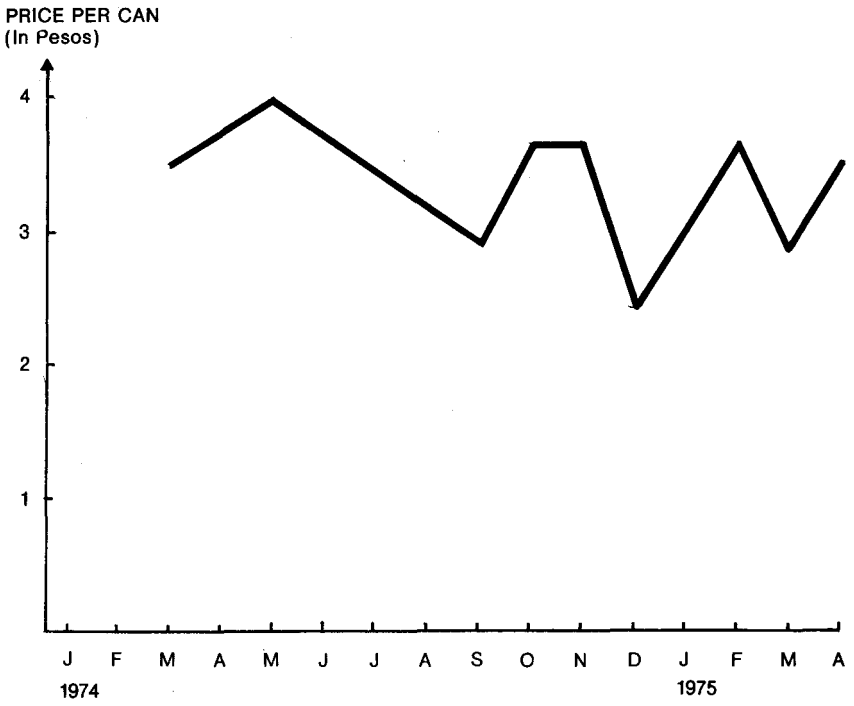


Table 29. Proportion of labor use per mussel farm (In man-days)

	For 600 sq m and below	For 601 sq m and above	Average per operator
Owner-operator's labor	19.57	34.35	26.96
Family labor	—	23.53	23.53
Hired labor	17.86	26.68	22.95
Exchange labor	36.89	7.50	30.36
Others	19.50	41.00	28.10
TOTAL	53.78	71.17	62.47

Table 30. Disposal of mussel

Farm Size	Number of Respondents	Quantity sold (cans)	Price (pesos)	Value (pesos)	Quantity eaten (cans)	Quantity given (cans)
600 sq m and below	15	985	3.17	3,148	19	21
601 sq m and above	15	1,672	3.63	5,391	13	12
TOTAL	30	2,657		8,539	32	33

with their parents or in-laws. Twenty-seven per cent of the small-farm operators said that the income from tahong farms is sufficient; 60% said it is just enough, while 13% said that it is inadequate.

Some of the very serious problems faced by the operators are pollution and typhoons which bring about destruction or loss of the crop. The respondents, however, suggested that extension of financial and technical support from the government would further improve the present situation in tahong culture.

Oyster Farming

Three species of oysters or talaba are indigenous to Philippine waters, namely: talabang chinelas *(Ostrea iridalei),* kukong kabayo *(O. malabonensis)* and pulid-pulid *(O. palmipes).* Although talaba grows wild in the sea, it can also be cultured. The potential area for talaba culture in the Philippines is estimated to be 100,000 hectares covering tidal streams, estuaries, sheltered coves, bays and bayous. Oyster beds are found in Manila Bay, Bacoor Bay, Lingayen Gulf, and in Manat River, Pangasinan.

Culture techniques adopted by operators are stake, handling, broadcasting, or a combination of these methods (Table 32). Setting patterns appear to be bimodal, with a low peak in May and a high one in September-October (Figure 19).

Harvesting of talaba depends upon two factors: size of the bivalve and market demand. On the average, talaba are harvested 6.4 months after spat collection.

For the country as a whole, talaba are mainly sold wholesale to an outlet some 3 km away, at ₱6.60 per can on the average.

Receipts and expenses in oyster farms are either cash or non-cash (Table 33). An average oyster farm operator earns a net income of ₱2,450 per year.

Oyster cultivation requires an equivalent of the eight-hour man-days per farm from plot layout to marketing (Table 34). Cultch preparation, or boring holes on the empty shells and tying them in polyethylene cords, take 19 days. Plot lay-out and setting of cultches or bamboos require a total of 12 days. Guarding the farm is strictly practised in Southern Luzon for an average of 28 days per farm. The most labor-

Table 31. Cost and return per mussel farm

	600 sq m and below	601 sq m and above	All Farms
Number of farms	15	15	30
Average area (sq m)	327	3,242	1,784
Gross Income:			
Cash receipts	3,148	5,391	4,269
Non-cash receipts	323	406	365
Total gross receipts:	3,471	5,797	4,634
Expenses:			
Cash expenses	1,786	2,030	1,908
Non-cash expenses	217	86	151
Total Expenses:	2,003	2,116	2,059
Net Cash Income Over-Cash Expenses:	1,362	3,361	2,361
Net Income over Total Costs	1,468	3,681	2,575

Table 32. Average size of oyster farms by Culture method

Region	Culture Methods					All Farms
	Stake	Hanging	Lattice	Hanging & lattice	Broad-cast	
Ilocos:						
Number	40	10	42	7	—	99
Area	362	250	472	245	—	389
Cagayan Valley:						
Number	—	—	—	—	6	6
Area	—	—	—	—	3,678	3,678
Southern Luzon:						
Number	15	33	—	—	—	48
Area	2,903	5,725	—	—	—	4,843
Western Visayas:						
Number	8	2	—	—	—	10
Area	5,375	32,500	—	—	—	10,800
All Farms:						
Number	63	45	42	7	6	163
Area	1,603	5,698	472	245	3,678	2,460

consuming operation is harvesting, this being highest in Cagayan Valley where the broadcasting method is employed.

The expansion and development of the industry is observed to be very slow due to these problems: strict rules and regulations prohibiting the setting of oyster culture materials in many areas, peace and order, unavailability of culture materials, unfavorable price structure, and lack of technical assistance from the government.

Siganid Culture

Siganid or malaga *(Siganus canaliculatus)* is considered a secondary species in Philippine fishponds. Only very few fishpond operators culture malaga because of lack of information on its culture and profitability. In fact, siganid fry or padas is made only into salted fish or bagoong in most regions, except in Pangasinan where its culture has been popularized.

Some operators culture malaga, alone, while others polyculture them with either bangos or sugpo. Siganid monoculture farms have

Fig. 19. Setting Patterns of Cultches for Talaba Spat Collection

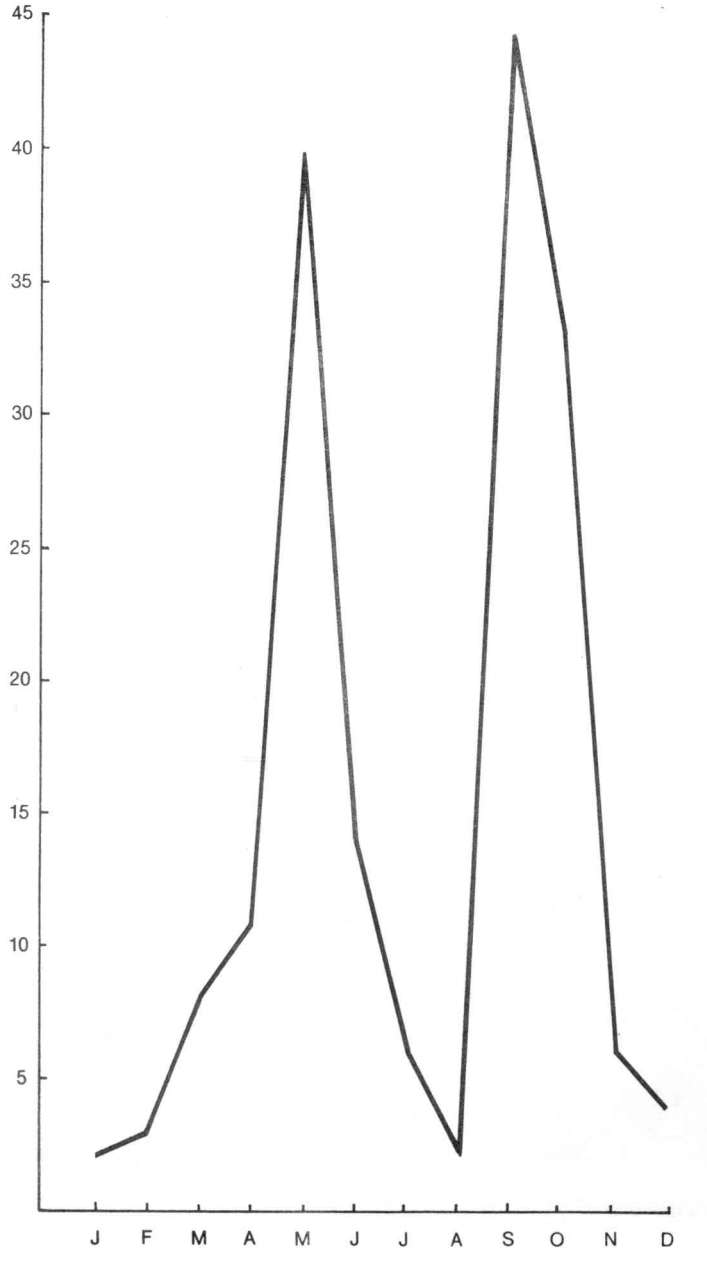
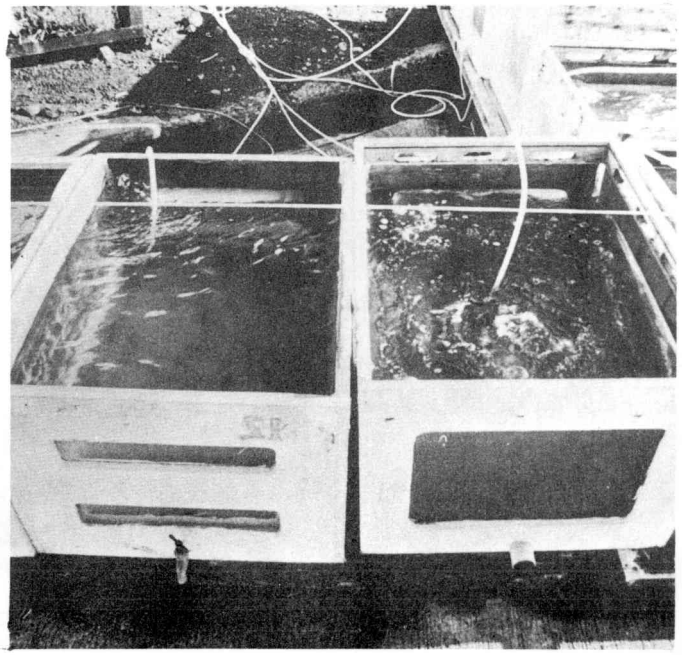


Table 33. Annual costs and returns from oyster farms (In pesos per farm)

Item	Ilocos	Cagayan Valley	Southern Luzon	Western Visayas	For all farms
Gross Receipts:					
Cash	691	580	9,205	2,627	3,313
Non-cash	90	(-7)	1,167	427	424
Total	781	573	10,372	3,054	3,737
Expenses:					
Cash	319	20	2,561	2,997	1,132
Non-cash	79	499	261	246	158
Total	398	519	2,822	3,243	1,290
Net Cash Income:	372	560	6,644	(-370)	2,181
Net Non-cash Income:	11	(-506)	906	181	266
Net Farm Earnings:	383	54	7,550	(-189)	2,447



an average area of 0.67 hectare while combination farms have an average of 1.98 ha.

Pond preparation is done 20 days prior to fry stocking. This includes general repair, pond cleaning and levelling of pond bottoms. Pests are eradicated using diluted pesticides poured on pond surface. Fertilization is practised with the use of the most common fertilizers such as ammonium phosphate and ammonium sulphate.

The padas are bought twice a year from the barrios along Lingayen Gulf. Mortality rates of padas are relatively low even though operators do not practise acclimatization of the fry. Stocking is mostly done in the morning.

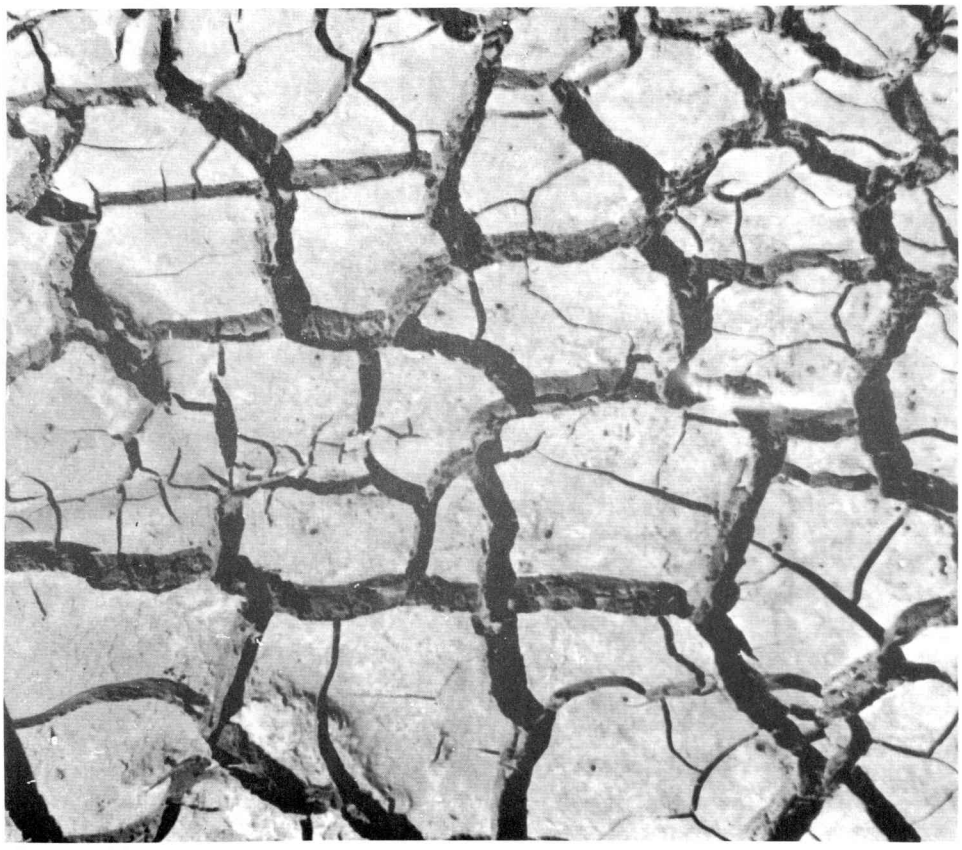
The annual average production is 548 kg per farm or 1,051 kg per hectare. Harvesting is done two times a year.

About 32 man-days are required for rearing a 0.67 hectare of pure malaga farm, or 59 man-days per rearing. Laborers are hired on a contractual basis for repair work and those who work on maintenance chores and harvesting are paid at the rate of ₱7 to ₱8 per day. Caretakers are paid on a commission basis, usually 30% of the net income.

Several problems encountered by the industry are: inavailability of technical support from the government, lack of proper infrastructure, and dearth of technical information on chemicals fertilizers and supplementary feeds.

Table 34. Labor Utilization in Oyster Farms (In man-days per farm)

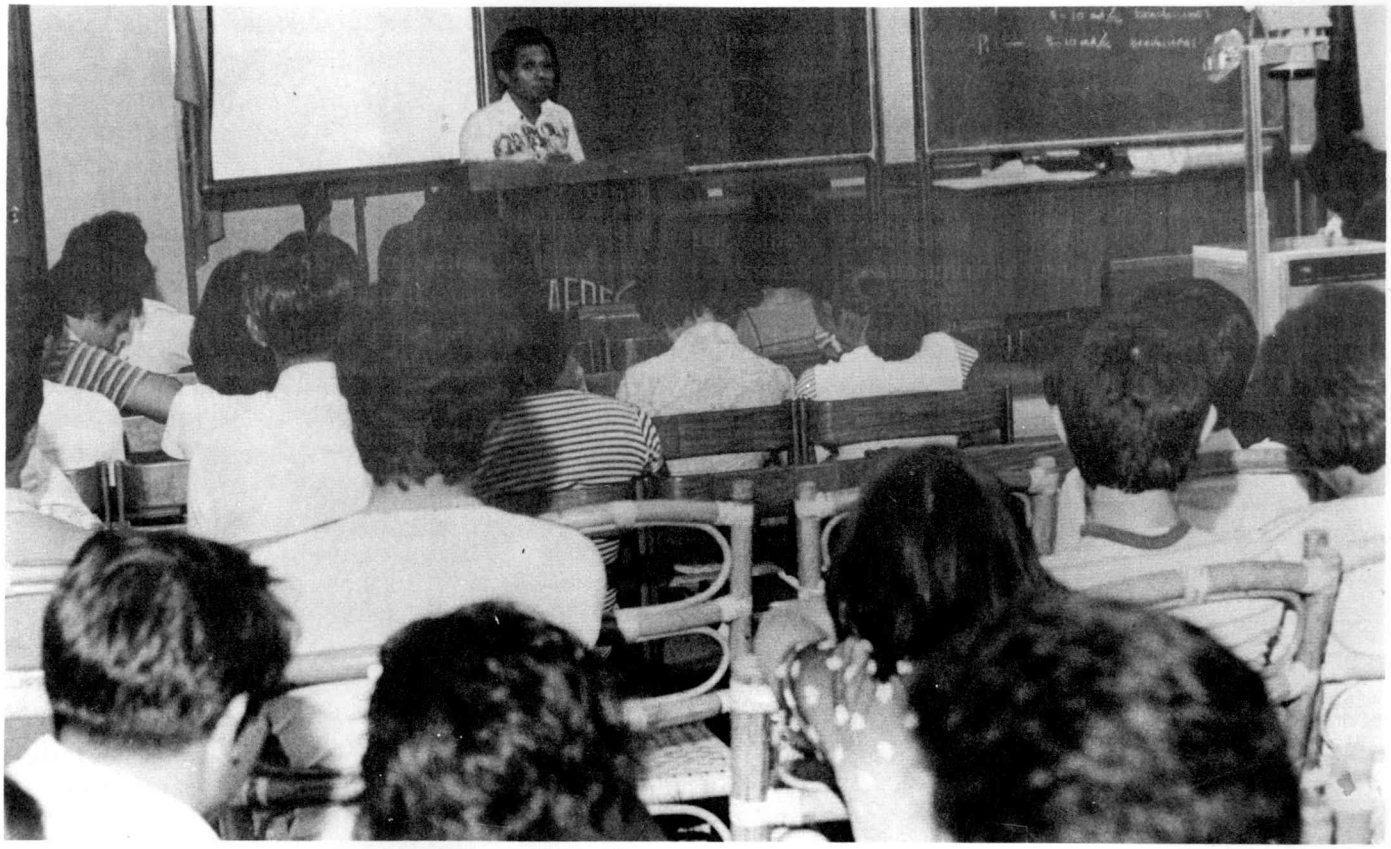
Operation	Ilocos	Cagayan Valley	Southern Luzon	Western Visayas	For all Farms
Plot layout	0.7	—	12.4	5.3	4.4
Cultch preparation	10.0	—	39.9	20.5	19.1
Setting of cultches/ bamboos	7.0	—	9.4	3.5	7.2
Guarding	4.4	—	28.3	16.0	12.0
Harvesting	11.3	82.3	22.0	55.2	19.8
Checking of cultches	1.8	—	0.7	—	1.3
Sorting	0.4	—	3.8	3.1	1.6
Shell removal	6.0	78.9	3.1	—	7.4
Packing or crating	1.1	2.9	3.1	10.2	2.3
Marketing	0.3	5.2	—	—	0.4
Supervision of operations	—	—	—	14.2	0.9
T o t a l	43.0	169.3	122.7	128.00	76.4

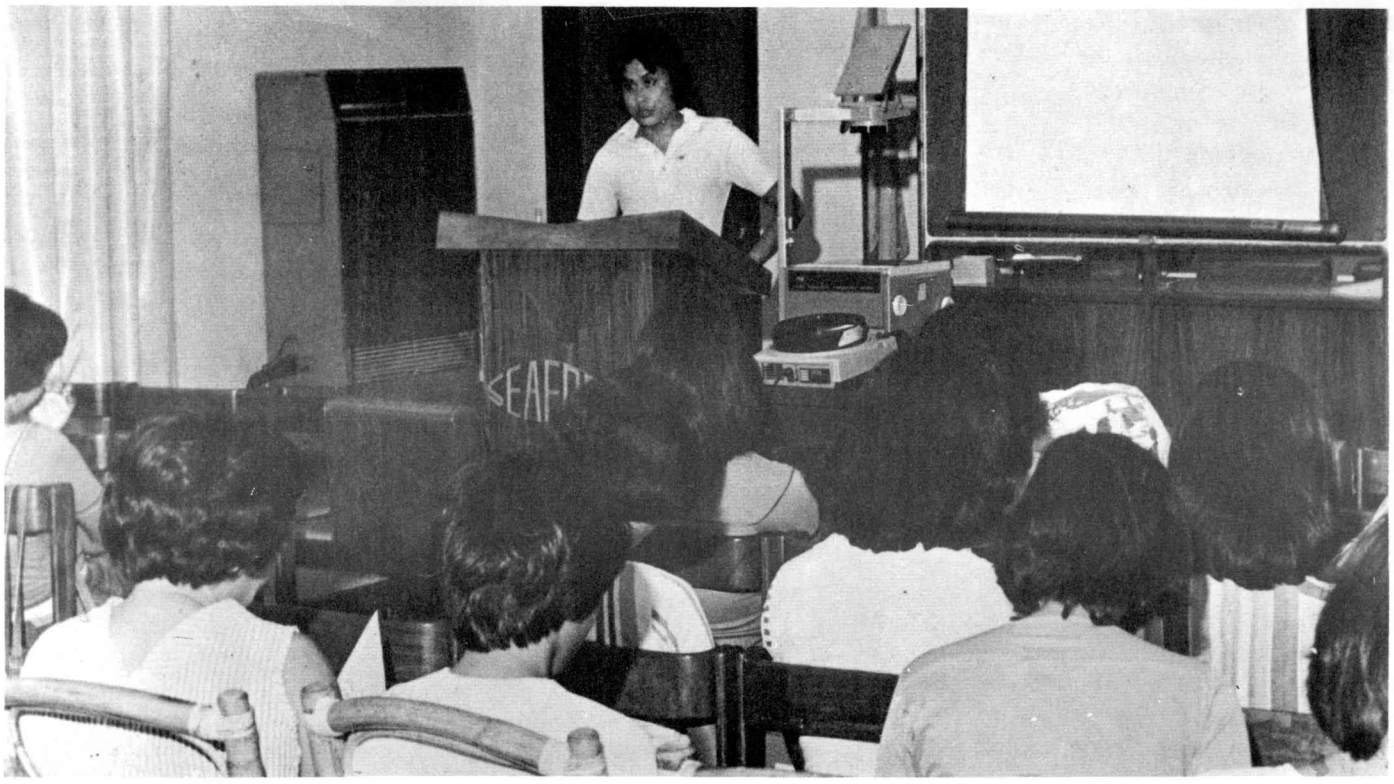


Pond preparation requires drying of pond bottom.

Mussels are examined in the laboratory

SEAFDEC mussel farm, Himamaylan, Negros Occidental





A session of the Southeast Asian Regional Training Program

TRAINING AND EXTENSION PROGRAM

The objective of our training and extension program is twofold: to produce technical manpower for the aquaculture industry and to hasten the transfer of technology from laboratory to the field.

During the previous year, we conducted 11 training sessions involving some 500 participants. These sessions could be classified into nine programs, four of which were offered in previous years. These programs are described below:

The Graduate Program in Aquaculture

In collaboration with the University of the Philippines System, a graduate program leading to a master's degree in fisheries, major in aquaculture, was successfully started where twenty-five students are presently enrolled. We provide the classrooms, laboratories and other facilities, while UPS faculty teach the academic courses. Classes are held in Tigbauan and Leganes, Iloilo.

Emphasis is laid on fish nutrition and reproductive physiology. Considering the importance of institutional linkages, consortium arrangements are being made with several universities in Canada, USA, Japan and Southeast Asia. These universities are planned to provide experts for the program. Under consortium arrangements, graduate scholars will take courses in affiliate universities abroad and will conduct thesis-research at the Aquaculture Department.

Southeast Asian Regional Training on Aquaculture Research

The first of its kind in the region, the ten-month program on aquaculture technology and research methodology was offered to representatives of member governments of SEAFDEC and other participants. Training started April 19, 1976 and ended February 17, 1977. The course work consisted of lectures, discussions, demonstrations, laboratory exercises, and field trips. During the last week, the participants discussed the status of aquaculture in their respective countries, plans for research and development, and their roles and functions in their own countries' programs. In consultation with their respective advisers, each participant conducted a semi-independent research on a selected aquaculture problem.

The participants in the 10-month regional training program in aquaculture research and the titles of their research work are as follow:

Visit of Southeast Asian Regional Training Program participants, Leganes Station

INDONESIA

Mrs. Sri Hartati Suprajitno
Directorate-General of Fisheries
Jl. Salemba Raya 16
Jakarta, Indonesia
Research Project: Survival rates of *Penaeus monodon* Fabricius postlarval stages in suspension nets and in plywood marine tanks.

MALAYSIA

Mr. Mohd Mazlan B. Jusoh
Fisheries Department
Kuantan, Pahang
Research Project: Larval development of *Penaeus monodon* Fabricius, *Penaeus semisulcatus* de Haan and *Metapenaeus ensis* de Haan, reared under laboratory conditions.

Mr. Lam Wah Chang
2 Jalan Awang, Segamat
Johore, Malaysia
Research Project: Observations on molting and effects of extirpation of *P. monodon* Fabricius in glass aquaria.

Mr. Teow-Loon Ti
2 Lorong Delima 14
Island Glades
Penang, Malaysia
Research Project: The effects of different types of feeds and feeding levels on the survival of *Penaeus monodon* larvae from $Zoea_1$ to $Mysis_2$ stage.

PHILIPPINES

Ms. Lilia Cha-Posugac
Bureau of Fisheries and
Aquatic Resources, Region No. 5,
Naga City
Research Project: The culture of *Chlorella vulgaris* and *Scenedesmus dirmorphus* as potential single cell protein source.

Mr. Cristobal B. Parreño
Iloilo Regional School
of Fisheries
Barotac Nuevo, Iloilo
Research Project: Combinations of dried shrimp head, rice bran and soybean cake as possible supplementary feed for *Penaeus monodon* Fabricius.

Mr. Jose T. Canto, Jr.
SEAFDEC Aquaculture Department
Tigbauan, Iloilo
Research Project: Tolerance of *Penaeus monodon* larvae to cupric sulfate added in bath.

Ms. Minda Valencia
Bureau of Fisheries and
Aquatic Resources
Intramuros, Manila
Research Project: The effect of salinity and temperature on the growth and survival of penaeid postlarvae.

Ms. Carmen Gempis
University of the Philippines
Iloilo City
Research Project: Effect of different densities on survival and growth of sugpo, *P. monodon* Fabricius in a milkfish rearing pond.

Mr. Jose Catarungan
Bureau of Fisheries and
Aquatic Resources
Research Project: Comparative efficiency of different types of feed of the fry and fingerlings of the Catfish, *Clarias macrocephalus* Gunther.

Mr. Ecclesiastes R. Matunog
Bureau of Fisheries and
Aquatic Resources
Research Project: The influence of chlorella density and salinity on population growth of *Brachionus plecatiris.*

THAILAND

Mr. Chanchai Sansrimachachai
Fisheries Biologist
Inland Fisheries Institute
Freshwater Fisheries Division
Thailand
Research Project: Study on the stocking rates of the fry and fingerlings of the catfish *Clarias macrocephalus* Gunther.

Mr. Kanit Chaiyakam
Fisheries Biologist
Songkhla Fisheries Station
Brackishwater Fisheries Division,
Thailand

Research Project: Effects of supplementary feeds on survival and growth rates of tiger prawn, *Penaeus monodon* Fabricius in rearing ponds.

Thanom Pimoljinda
Fisheries Biologist
Phuket Fisheries Station
Brackishwater Fisheries Division, Thailand

Research Project: Identification and culture of common diatoms as possible feed for *P. monodon*.

Songsit Limsakul
Fisheries Biologist
Rayong Fisheries Station
Brackishwater Fisheries Division, Thailand

Research Project: Observation on the effect of eyeball extirpation on the rate of growth, mortality and gonadal development of juvenile *Penaeus monodon* Fabricius in ponds.

Auaychai Khannapa
Fisheries Biologist
Research and Experiment for Aquaculture Unit
Brackishwater Fisheries Division, Thailand

Research Project: The effect of various protein levels on the growth and survival rates of *P. monodon* Fabricius.

Training on Prawn Culture.

In collaboration with the Bureau of Fisheries and Aquatic Resources (BFAR), a series of sessions to train people to adopt improved techniques of prawn culture was launched in November 1975, and became an ongoing program until December 1976. The program also disseminated information and equipped participants with skills in the rearing and culture of prawns.

About 95 BFAR extension workers and fisheries biologists, 11 fisheries school instructors, 47 pond technicians, 11 DBP personnel, and three Central Bank observers attended the training.

The International Milkfish Conference.

Sponsored by the Aquaculture Department and assisted by the International Development Research Centre (IDRC), the conference was organized as a sequel to the National Bangos Symposium held in 1975. The conference was held in May 1976 at the main station in Tigbauan, Iloilo. Major topics included: the behaviour and bio-ecology of the milkfish in the wild; egg and larval surveys; maturation and reproduction in the wild and in captivity; egg incubation and larval rearing; predators, diseases, and physiology of stress;

The International Milkfish Conference focused on recent developments and findings in milkfish culture and reproduction

and the establishment of a research network for countries and institutions engaged in milkfish research.

Participants in the conference were divided according to areas of concern. They agreed on the following research emphasis of participating institutions. (1) **Physiological maturation and induced breeding** to be conducted by Taiwan, SEAFDEC Aquaculture Department, and the Oceanic Institute; (2) **Morphological racial studies** to be conducted by Japan, while **biochemical racial studies** were assigned to the Oceanic Institute and the Hawaii Institute of Marine Biology; (3) **Larval rearing** to be conducted by Taiwan, SEAFDEC, BFAR, UP, Hawaii Institute of Marine Biology, Oceanic Institute, India and Indonesia; (4) **Migratory and spawning studies** assigned to SEAFDEC, Oceanic Institute, and Thailand; (5) **Reference repository** assigned to SEAFDEC; (6) **Sex determination** to be conducted by SEAFDEC; (7) **Cryogenic preservation** of milt, by Taiwan and SEAFDEC; (8) **Pituitary bank,** by SEAFDEC; and (9) **Egg and larval survey,** by SEAFDEC, UP, BFAR, India and Indonesia.

Cooperators' Training Program

The objective of this program is to institutionalize the linkage with the private sector and to transfer proven techniques in the culture of milkfish and prawns, and management of ponds.

Three training sessions were conducted for 69 new cooperators from Region VI, and two from outside the region. A total of 1,465,000 fry were distributed to 48 cooperators from January 7 to October 15, 1976. The officers and members of the Board of Directors of the Western Visayas Federation of Fish Producers became cooperators and they collaborated with us in the training of Mindanao pond owners who were victims of the August earthquake. They invited trainees to their ponds, and provided prawns for research purposes.

With the acquisition of new tools and equipment, we have improved data collection for our Cooperators' Program. The questionnaire on pond management practices was modified to acquire additional information from cooperators. The program will be continued in the incoming years, particularly with the increase in fry production in our hatcheries.

Technician Training Program

Intended primarily for private pond technicians, the program hopes to generate interest in the adoption of improved methods in prawn culture. The first session was held in Tigbauan, from January 19 to February 7, 1976 with 15 pond technicians and one teacher from the Iloilo School of Fisheries as participants. The program was designed to upgrade the pond technician's knowledge and skills in prawn culture, and to minimize the knowledge gap between the cooperator and his technician. A total of 10 sessions was held. Under the program, BFAR extension workers assisted us in terms of lectures and technical guidance

Release of prawn fry in cooperator's pond.

while pond owners provided the use of the ponds and stock, including other inputs required for culture. The technician training program forms an integral aspect of the Cooperators' Program.

Like other ongoing programs, the technician training program will be expanded in 1977, with the participation of more BFAR extension workers, fishpond operators and technicians, artisanal fishermen, and selected participants from Southeast Asia.

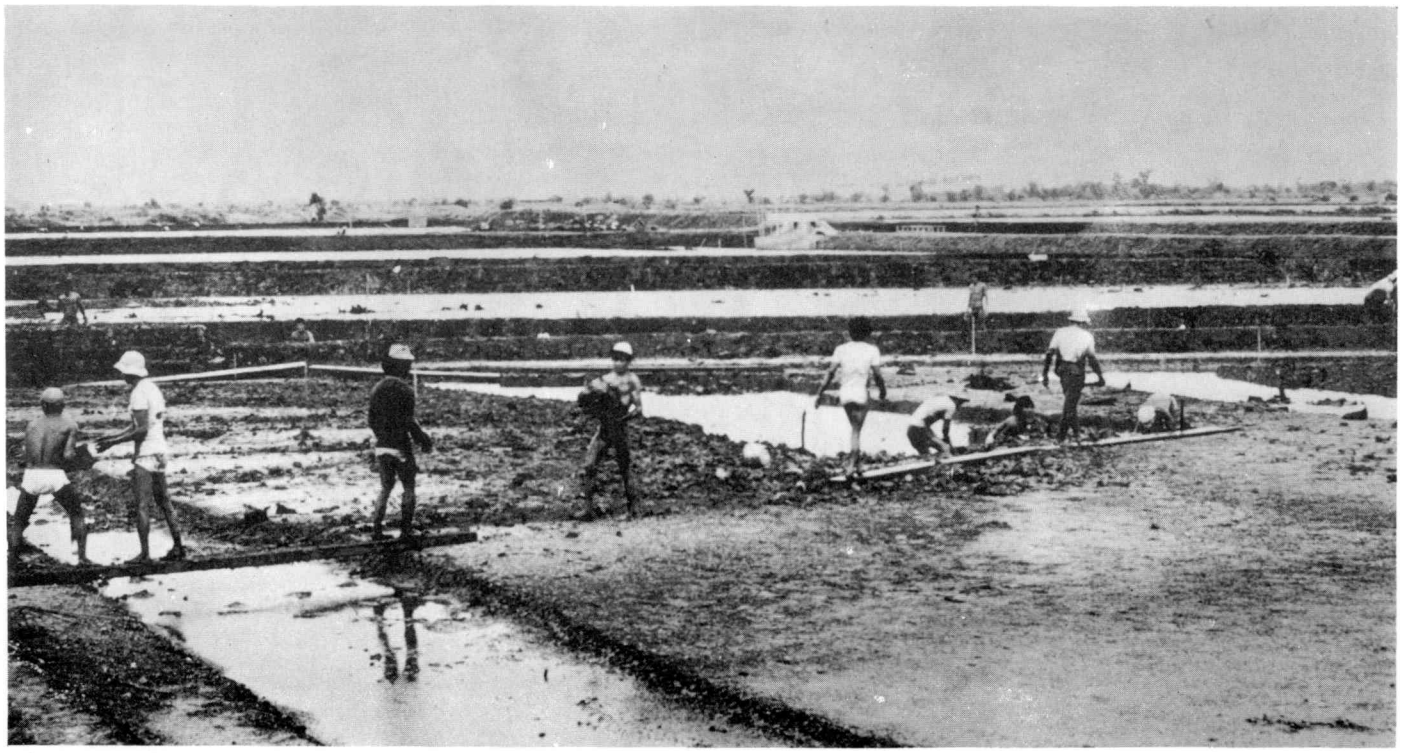
Training on Pond Construction and Management

Conceived as an assistance program to the victims of the recent earthquake in Southern Mindanao, special training was given in Tigbauan, Iloilo from September to November 1976. Ninety-four participants attended the two sessions which we sponsored with the Bureau of Fisheries and Aquatic Resources, and the Western Visayas Federation of Fish Producers, Inc. The program was strengthened by the signing of a Memorandum of Agreement between Director Felix Gonzales of BFAR, Rear Admiral Romulo Espaldon of the AFP South Command, and Dean D. K. Villaluz of SEAFDEC regarding the acceleration and intensification of fisheries development in Mindanao and Sulu.

We tried to expose Mindanao pond owners to the importance of properly constructed ponds based on improved design, methods, and construction. Knowledge and skills in pond management including methods of harvesting, processing, and marketing of fishpond products were shared by the participants.

Training was given in the form of lectures and field trips. Among the items discussed were: site selection; pond management including pond preparation, culture techniques; harvesting, transport, marketing; problems and suggested solutions. Lecturers came from the three fisheries organizations that sponsored the training program. We invited resource persons from various institutions.

The training is unique in many ways. While it was conceived as an assistance program to disaster victims, it was also designed to influence the participants to shift from traditional to more advanced pond culture practices. The leadership of those concerned stimulated efforts of all to help in the development of fisheries in Mindanao. From another perspective, it demonstrated that the private operators can actively and ably join the government in development work. Finally, the SEAFDEC can contribute to national development by sharing its facilities and expertise.



Renovation of old milkfish ponds

Special and Short-term Training Programs

We conducted a series of seminar-workshops on fisheries engineering from December 11, 1976 to January 28, 1977. About 217 participants from DNR, BFAR, NSDB, PCARR, UP, CLSU, MSU, PFFP and SEAFDEC attended the workshops. The guest lecturer was Dr. Juichi Katoh, a well-known expert in fisheries engineering and professor of the Tokyo University of Fisheries, Department of Environmental Hydraulic Engineering. He was assisted by Col. Benjamin Lerma of the PFFP, Dr. Catalino de la Cruz of CLSU, engineers Alfredo Lopez, Vivencio Ticao and Tirso Jamandre of WVFFP, and Ricardo Hechanova. Interpreters were Dr. Katzuso Kuronuma and Ms. Tomoko Kuronuma. Four sessions were held from December to January.

We also presented in cooperation with BFAR, the National Seminar on Fishery Law Enforcement held at Tigbauan, Iloilo from February 16 to March 6, 1976. The seminar was attended by 60 fishery agents from the different regional offices of BFAR. Representatives from the Philippine Coast Guard also attended the 18-day seminar.

Visitors

From various countries and institutions came experts in the field of aquaculture and other related sciences either to visit or to train in our research stations and facilities. Among those who came were the following: Mr. H.R. Vespry of IDRC Singapore, Director Chin Phuy Kong of the Malaysian Department of Fisheries, His Excellency, Ambassador Daniel Nutter of Australia; SEATO Secretary General Sunthorn Hongladarom of Thailand; Mr. Alan Rietow of Avenue Fisheries Research Station in Honolulu; Dr. W. H. Allsopp, Associate Director, Fisheries, IDRC, Vancouver; Dr. K. Kuronuma, former President, Tokyo Fisheries University; Dr. Brian Davy, Programme Officer, IDRC, Vancouver; Dr. D.B. Quayle, an oyster expert; Dr. Dick Lara, Technical Coordinator of Projects, Camarao, Brazil.

Dr. Tyson Roberts of the Smithsonian Institute, Washington D.C.; Dr. Philip Helfrich, Director of ICLARM and Dr. Ziad Shehadeh, ICLARM Associate Director and Mr. Luis Marcano of Venezuela; Prop. T. Atibola Taylor of Nigeria; H.J. Oslage of Germany and H.C. Pereira of London — TAC members.

Participants in a Training Program on Prawn Culture

Mr. Neil Mckee, Head of the IDRC Audio-Visual Department; His Excellency, Ambassador Macleod Chapman of New Zealand; Dr. Deb Menasveta, SEAFDEC Secretary-General; Dr. John Melford, Deputy Representative, UNDP; and Mr. Campbell McCullough, Country Representative of UN-FAO; Dr. R. Dennis, Dean of Agriculture, Auburn University; and Dr. R. Wayne Shell, Head, Fisheries Department, Auburn University; Dr. Eric Watts, Project Adviser of IDRC.

Dr. I-Chiu Liao, Director of Taiwan Fisheries Research Institute; Mr. Dong Liang Lee and Mr. Ching Shan Cheng, senior specialists of same institution; Mr. P.R.S. Tampi of the Indian Council of Agricultural Research; Mr. K.H. Alikunhi, Project Manager of UNDP-FAO Project at Jepara, Central Java, Indonesia and Dr. Ali Poernomo, Co-Project Manager.

Dr. Takeichiro Kafuku, Chief, Fish Culture Division, Freshwater Fisheries Research Laboratory, Tokyo; Mr. Ong Kee Bian, Senior Fisheries Officer, Department of Agriculture, Sarawak, East Malaysia; Mr. Chin Phui Kong, State Fisheries Officer, Department of Fisheries, Sabah, East Malaysia; Dr. Jean M. Griessinger of AQUACOP, Tahiti, French Polynesia; Jacques Perrot, Deputy Director General of CNEXO, Paris; Mr. B. Sivaraman, India Planning Commission; Mr. Hiroshi Saito of JICA: Minister Azizal Hik of Bangladesh Ministry of Agriculture; Vice Minister Le Duy Trinh of the Ministry of Agriculture, Vietnam; Mr. Li Yung Kai, Minister of Agriculture, People's Republic of China; Mr. Yuichiro Ito of the Japanese Ministry of Foreign Affairs; Mr. Cheah Eng Kean, representative of the Malaysian SEAFDEC Council Director; Director Tuanthai Bamrajarinpai, Chairman of the SEAFDEC Council of Directors (1976); Dr. S. Shindo, Deputy Chief of Training Department; Capt. Samarom Bunnag of Royal Thai Navy and General Affairs, Training Department; Dr. Veeravat Hongskul from the Department of Fisheries, Thailand; Dr. Elek Woynarovich from the UNDP-FAO Fisheries Project in Venezuela; Dr. B. Entz and four other Hungarian scientists; Dr. R.E. Drinnan, Director of Cape Breton Development Corporation, Marine Farming Research Branch, Nova Scotia, Canada; Dr. and Mrs. John C. Marr, Chairman, Mardella Fisheries, Ltd., Honolulu; Mr. and Mrs. John Huyser, Director, FAO Investment Center; Dr. Harold

Participants in the Regional Aquaculture Training Program

Webber, President of World Mariculture Society.

His Excellency, Ambassador Masao Sawaki of Japan; Dean R. Juliano of the UP College of Fisheries; Dr. H.R. Rabanal of South China Sea Fisheries Development and Coordinating Programme; Director Felix R. Gonzales of BFAR; Dr. Manuel Alba, Deputy Director, NEDA; PCARR Director-General Joseph Madamba; LLDA Assistant Manager Teodoro Baguilat and Dr. H. Lenarz, German consultant for LLDA; Mr. Harry Cook of SCSP; NEDA Director-General Gerardo Sicat; Dr. Armand Fabella, National Reorganization Commission; Rear Admiral Romulo Espaldon of the AFP South Command; Mr. Sato Iwamoto, First Secretary of the Japanese Embassy to the Philippines; Mr. J. Tanchangco, NGA Secretary; the Counselor and First Secretary of the People's Republic of China Embassy to the Philippines; scientists and officials from other research institutions; Peace Corps volunteers, businessmen, students, and teachers.

Library Development

As part of the Training and Extension Program, the library was built to serve researchers, trainees, and students of aquaculture. Library development was accelerated with the transfer of physical facilities from the original building to a new one and the purchase of books worth $32,106 from Blackwell North America, Inc., and ₱33,676 from local bookstores.

The new air-conditioned library is more spacious than the old one, having a seating capacity of forty. During the second half of the year, we introduced a referral service to project heads, station heads and researchers. The library has already produced three bibliographies on prawns, milkfish, and catfish. In addition, a modest one-page annotated list of new acquisitions was published from time to time. With the offering of an international training program and a masteral degree program, the staff extended library hours to 10:00 o'clock p.m. during weekdays and the whole day, Saturday. Monthly use increased gradually from January to June, but a sudden influx of readers was noted during the second half of the year (average monthly attendance from January to June was 459 while the average from July to December was 2,376). Borrowing also increased sporadically except during the vacation months.

From 220 volumes at the beginning of the year, the collec-

tion has grown more than ten times to about 2,320 books. Of the total number, 82% were foreign and local purchases and 18% came as gifts and exchanges from FAO, IDRC, and the Indo-Pacific Fisheries Council. The collection includes titles in aquaculture, algae, fishes and fisheries, food science and technology, marine biology and chemistry, oceanography, and the basic sciences.

The pamphlet and reprint files recorded a tremendous growth during the period. From 200 pieces in January of 1976, the number grew to 1,500 pieces. These materials came mostly as gifts. Some were given by a staff-in-residence in Tigbauan.

The library received 41 periodical titles. It also subscribed through Faxon Company 113 journal titles. As gifts and exchanges, the library received thirty serial titles.

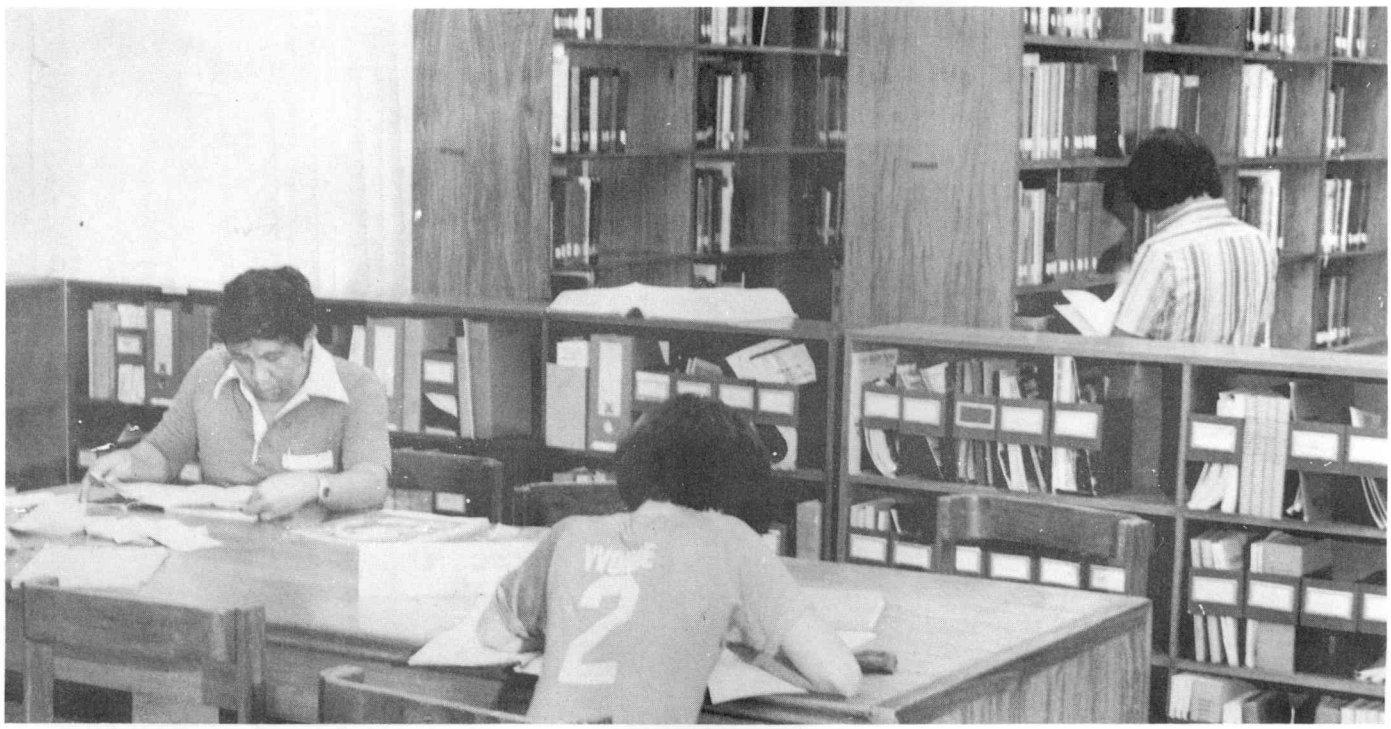
The start of a microfilm collection also developed during the year. The library received 22 microfiche titles on fisheries, algology, and industrial economics from the USAID. More titles covering extension work, fisheries and aquaculture, and research management are expected to come.

Among the technical services completed during the year were, the indexing of important fisheries journals, cataloguing and classification of books, book selection and ordering, and the establishment of exchanges with fisheries libraries and institutions.

Working relationships with information centers were made during the year. The Library received assurance of access to the services of the National Aquaculture Information Systems (NAIS) of the U.S. National Oceanographic Data Center. We have enrolled with PCARR's Scientific Literature Service and have fulfilled some preliminary requirements for a working relationship with SEARCA's Agricultural Information Bank of Asia (AIBA).

New Training Center Building

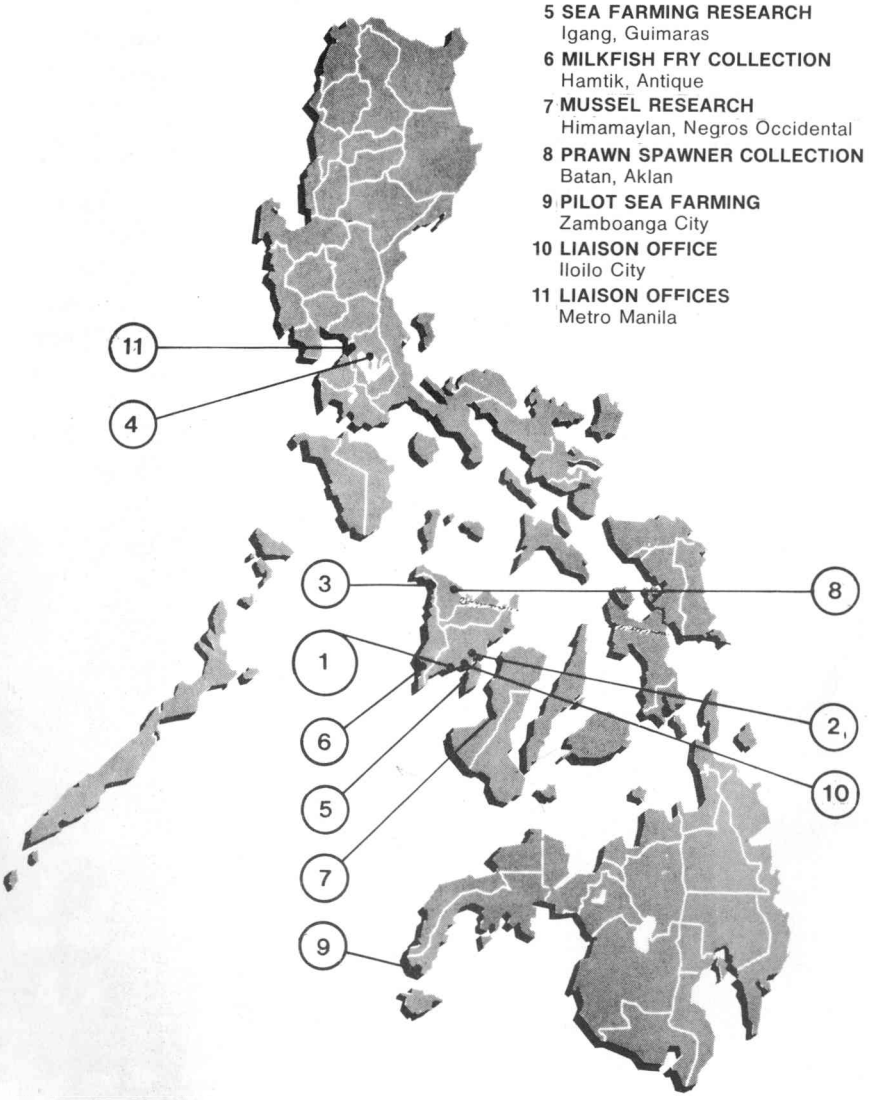
A recently completed building In the Tigbauan complex now houses the training and extension unit. The center also houses the library, classrooms, the UP-SEAFDEC Graduate Study Program offices, and an audiovisual room which also serves as a conference room. The International Milkfish Conference was held in this building. The influx of guests to our Department has been steadily growing since its operation; one of the jobs of the center is to attend to foreign and local visitors.



One of the best in the region, the Aquaculture Department library services researchers and graduate students.

PROJECT SITES

PHILIPPINES



1 MAIN STATION
Tigbauan, Iloilo

2 POND SYSTEM
Leganes, Iloilo

3 MILKFISH RESEARCH
Pandan, Antique

4 FRESHWATER AQUACULTURE
Binangonan, Rizal

5 SEA FARMING RESEARCH
Igang, Guimaras

6 MILKFISH FRY COLLECTION
Hamtik, Antique

7 MUSSEL RESEARCH
Himamaylan, Negros Occidental

8 PRAWN SPAWNER COLLECTION
Batan, Aklan

9 PILOT SEA FARMING
Zamboanga City

10 LIAISON OFFICE
Iloilo City

11 LIAISON OFFICES
Metro Manila

PROJECT SITE DEVELOPMENT

Summary

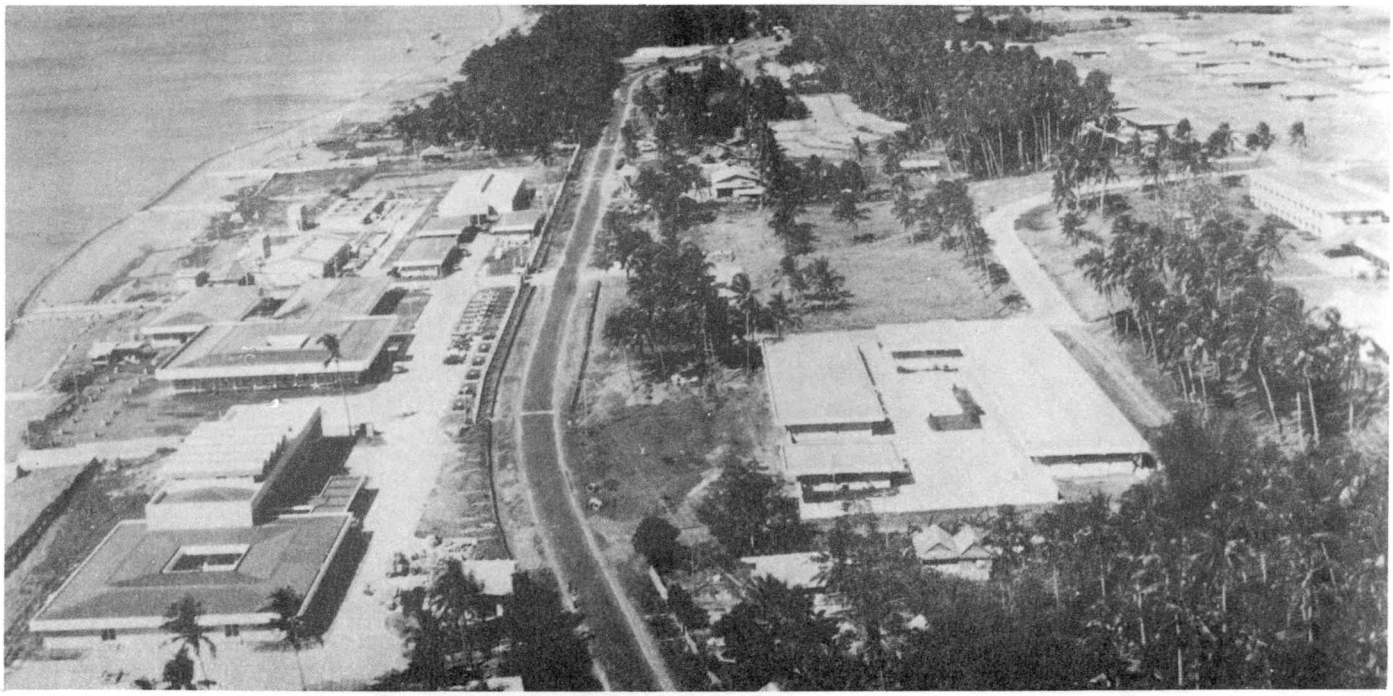
We operate six research stations: 1) a main station at Tigbauan, Iloilo, 2) extensive ponds at Leganes Iloilo, 3) a milkfish research station at Pandan, Antique, 4) a seafarming station at Igang, Guimaras Island, 5) a freshwater aquaculture station at Tapao Point, Binangonan, Rizal and 6) an outreach station for pilot studies in seafarming at Zamboanga in connection with the rehabilitation program in Mindanao.

The first three stations were established in our first three years of operation. The next three stations are in the process of development. All six stations and others to be set up in the future are in accord with our approved Plan of Operation and Program of Work.

Tigbauan Main Station

This station has grown from a five-hectare site to a 40-hectare research complex in barrio Buyuan, about 26 km south of Iloilo City. It was selected on the recommendation of a Japanese survey team headed by Dr. Katsuzo Kuronuma, former President of the Tokyo University of Fisheries.

Construction work is programmed in four phases. The first two, completed April 1975, saw the rise of these facilities: a laboratory building with a floor area of 525 sq m for studies in food preparation, water quality and fishpond engineering; a laboratory building with a floor area of 525 sq m for studies in chemistry, biology, pond culture and seed production; a field laboratory with a floor area of 300 sq m for periodic biological, chemical, and water analyses; a wet laboratory building with a floor area of 525 sq m for the culture of food organisms, studies on the life cycle of crustaceans and fishes, and bio-assay studies on undesirable organisms; a covered hatchery with six 50-ton tanks and another six 120-ton tanks; and an open-air hatchery with four 200-ton tanks; a nursery pond for rearing juvenile prawns (P_{25}) and for studies on salinity tolerance, feeding requirements, stocking rates, predation and cannibalism; a food preparation building with three freezing compartments, each with a floor area of 80 sq m and food preparation facilities; a dormitory with a floor area of 924 sq m with 20 rooms, 8 of which are provided with private bath for guests and lady trainees; a cafeteria with a floor area of 240 sq m adjacent to the dormitory and connected to it by a covered

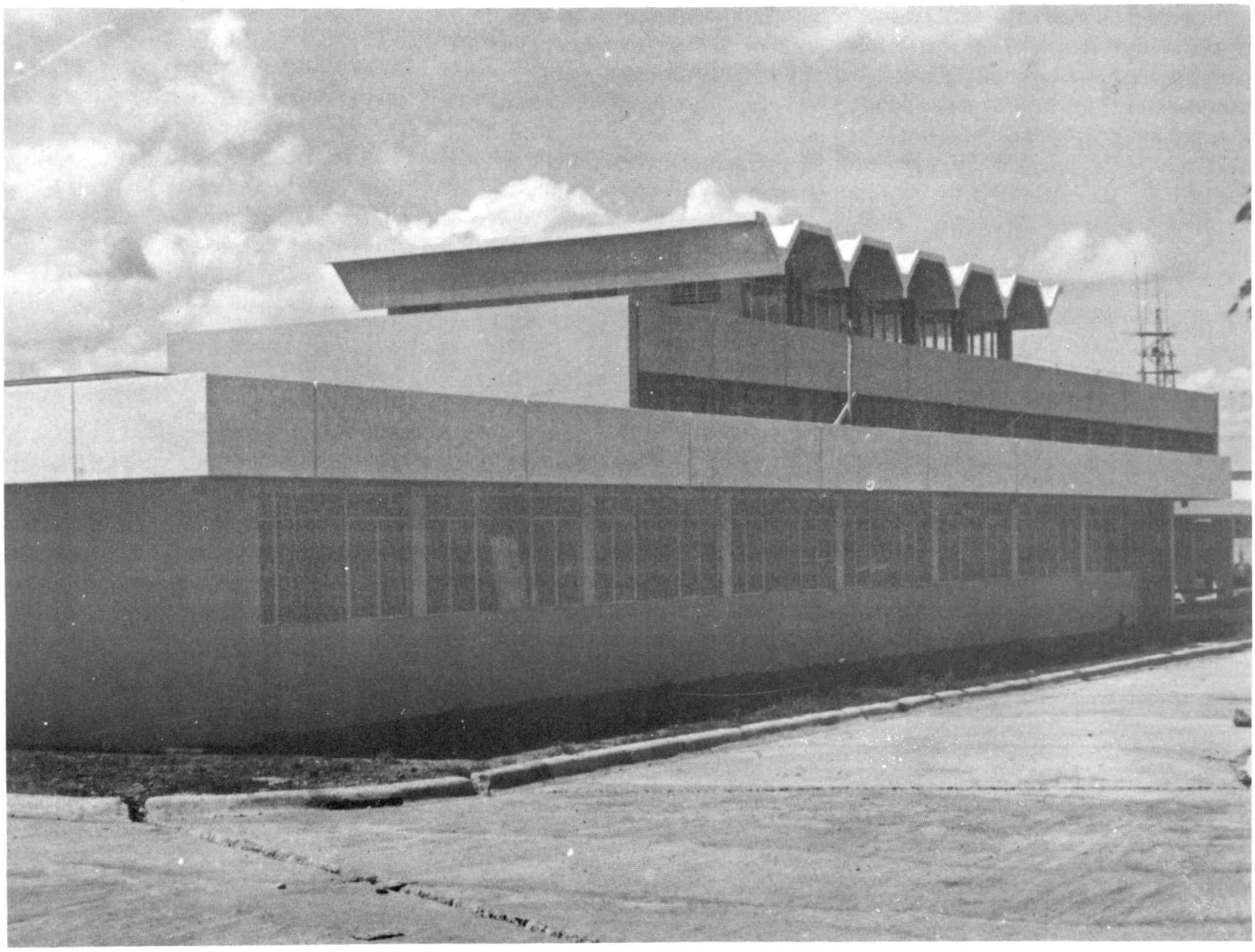


Main Station, Tigbauan, Iloilo

walk; a physical plant complex consisting of a motor pool, a gasoline pumping station, a motor repair and maintenance shop, a machine shop, carpentry shop, storerooms and offices.

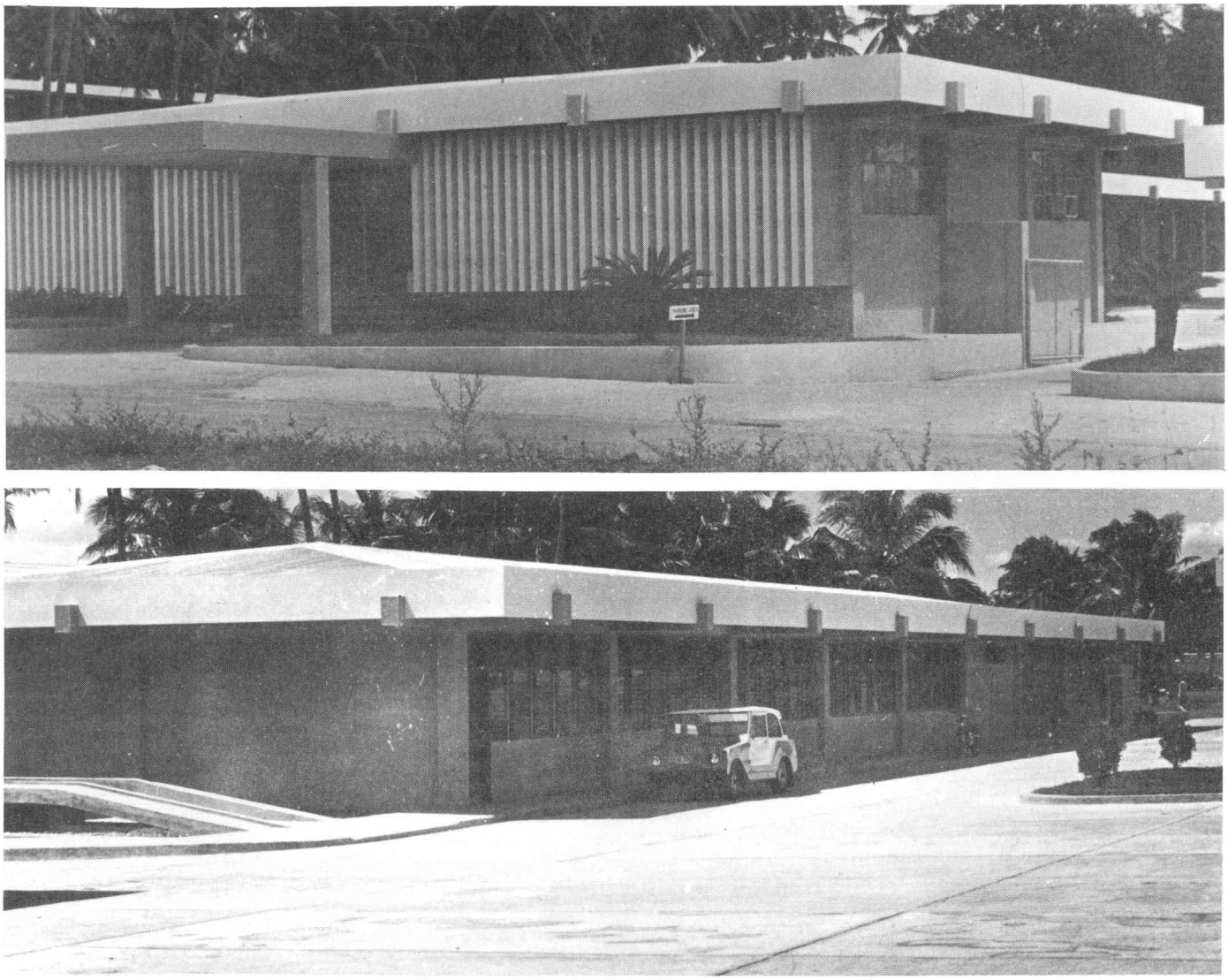
For Phase III, the facilities which were built in August 1976 are: a three-storey administration building with a floor area of 1928 sq m, with centralized airconditioning; an apartment building with a floor area of 1680 sq m with 40 rooms, each equipped with a bathroom and dining room, kitchen, toilet and balcony; a library and training complex with a floor area of 2299 sq m consisting of offices, classrooms, audio-visual and conference rooms, printing and bindery; twenty-six two-bedroom staff houses each with a floor area of 135 sq m and additional civil works; a water distribution system, sewer collection system and power distribution system. The Alpha Company of the 552nd Engineering Construction Battalion under the 51st Engineering Brigade of the Philippine Army constructed the following: concrete paving of roads, filling of low portions, backfilling, cleaning of access road, cocopile driving, road asphalting and construction of parking spaces and drop inlets. Also in cooperation with PAG-ASA, a hydro-bio-meteorology station was set up to gather basic information on the environmental conditions in the area.

The final phase started in October 1976. It called for the construction of a two-storey laboratory for nutrition and reproductive physiology studies, additional lecture and laboratory facilities for training, conference and seminars, recreational and other auxiliary service facilities, and completion of the electrical, sewage and road systems. We expect to finish all these works by the end of 1977.



Administration Building, Tigbauan Main Station

Apartment house, Tigbauan Main Station



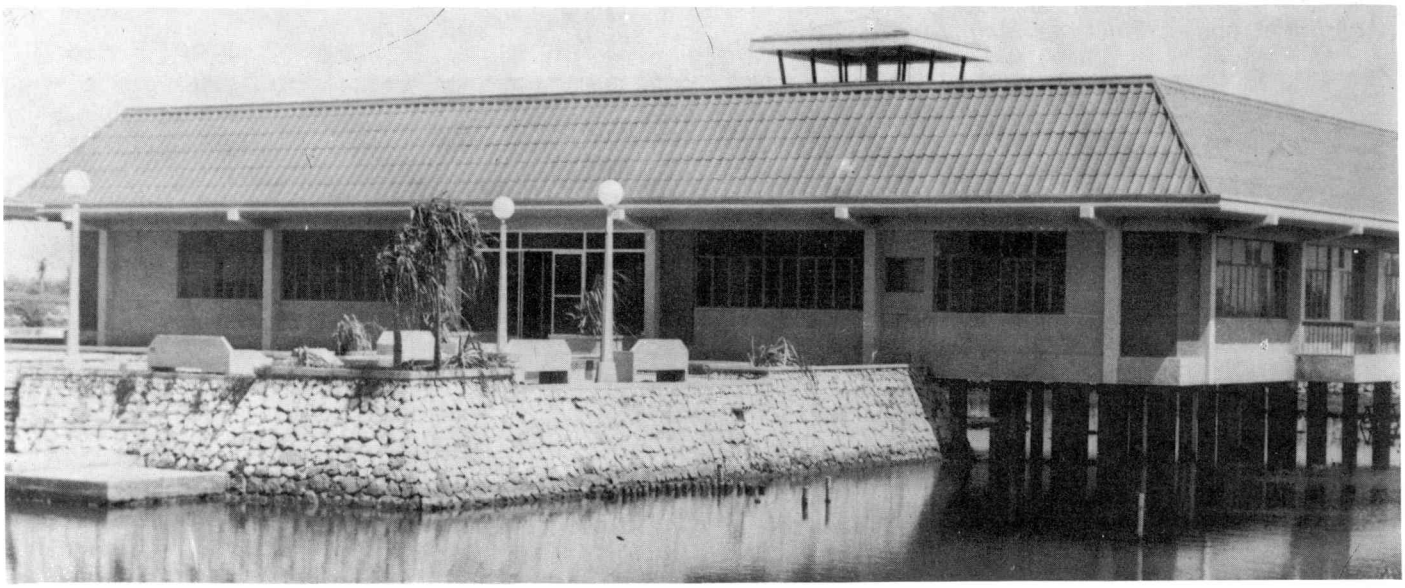
Training and Extension Building, Tigbauan Main Station (front & rear view)

Leganes Station

This station grew in size from 10 hectares of experimental ponds to a 96-hectare pond system at a site northeast of Tigbauan and Iloilo City. Thirty hectares of the project site face the Iloilo Strait where purely marine water is available. Thirty five hectares are adjacent to a tidal creek with brackish-water, and the rest of the site adjoins a river whose water has low salinity at low tide. Pond soil is from clayloam to sandy clay, both conducive to good algal growth. Soil and water pH range from 7.0 to 8.5. Average pond bottom elevation is from 3 to 4 ft. above seawater. Because of the availability of saline, brackish and freshwater, the site is suitable for research and production of commercial finfish and shellfish as well as algae.

From Iloilo City, the project site is accessible by land and water. The system is also adjacent to the UP-Brackishwater Aquaculture Center project where graduate students train in fish culture and which serves as a demonstration station for improved methods of fish culture for fishpond operators and foreign observers.

Along with 96 hectares of ponds, the stations's facilities as of December 1976 included a field



Research laboratory complex, Leganes Station

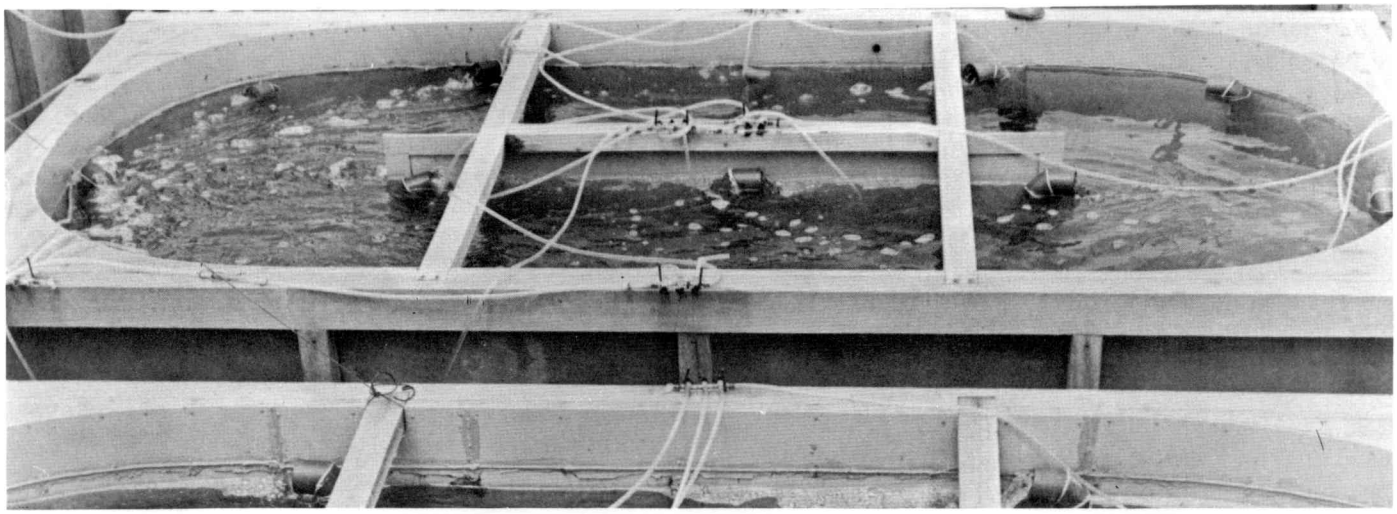
Administrative Offices, Leganes Station

research laboratory complex with a total floor area of 720 sq m consisting of a chemical and biological laboratory, library, seminar and projection room; administrative offices, photo dark-room, and an observation tower which will be built at the center of an open court; a utility building with floor area of 192 sq m housing electric power and repair facilities, chemical storage and fertilizer storage; a duplex building with a floor area of 160 sq m serving as residence for house staff and visiting researchers. Other facilities include dike walks, boat landing, water supply and distribution system, septic and drainage system, electric light and power system and landscaped open spaces.

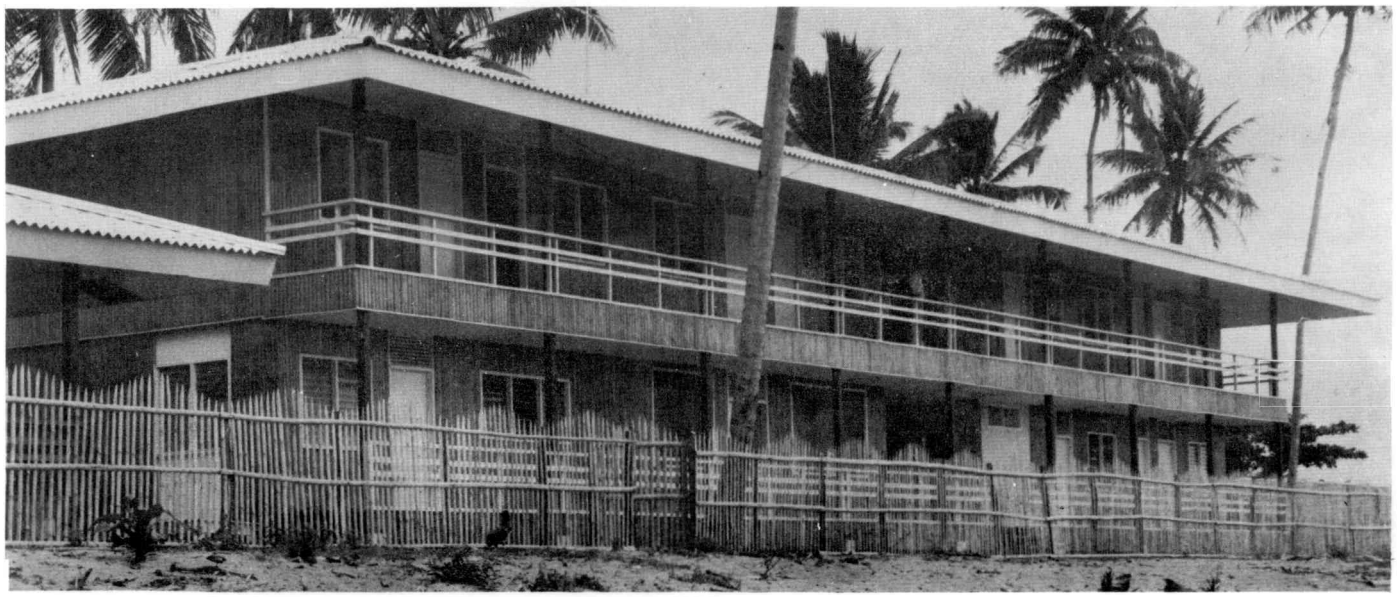
Pandan Milkfish Station

This station, which is being supported by an IDRC grant, is located in Mag-aba, Pandan about four hours by road northwest of Tigbauan. The choice was dictated by the abundance of adult milkfish and fry in Pandan Bay, the presence of two otoshi-ami nearby for trapping sabalo, and availability of fresh as well as seawater.

Its facilities include a one-storey wooden building with a total area of 200 sq m which houses the dry and wet laboratories. The dry laboratory is used for general analysis and photomicrography; the wet laboratory, for egg hatching and culture of food organisms. The building also has a workshop and a radio which links the station with Tigbauan and Manila.



Race ways used for seed bank experiments.

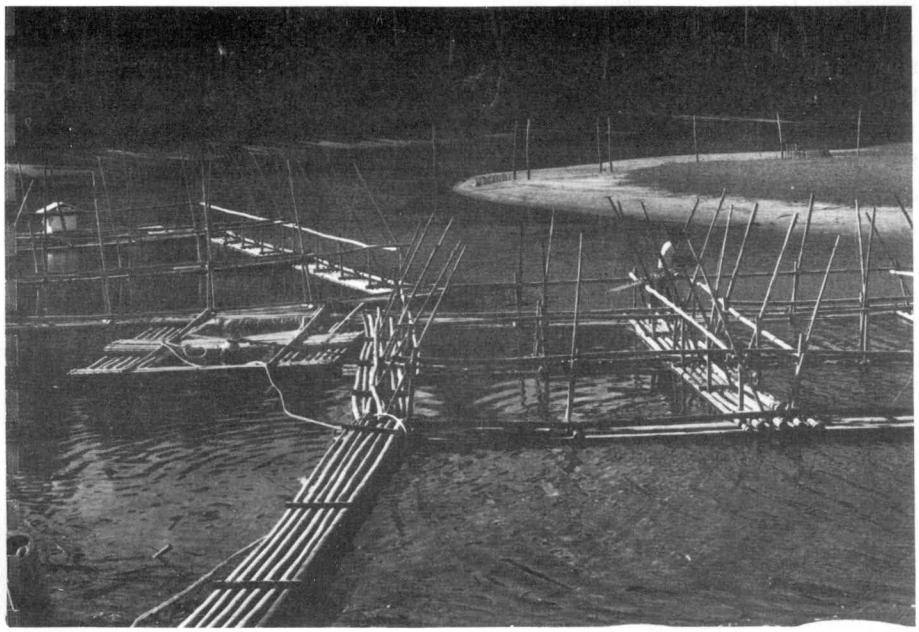


Dormitory and guest houses, Pandan Milkfish Research Station

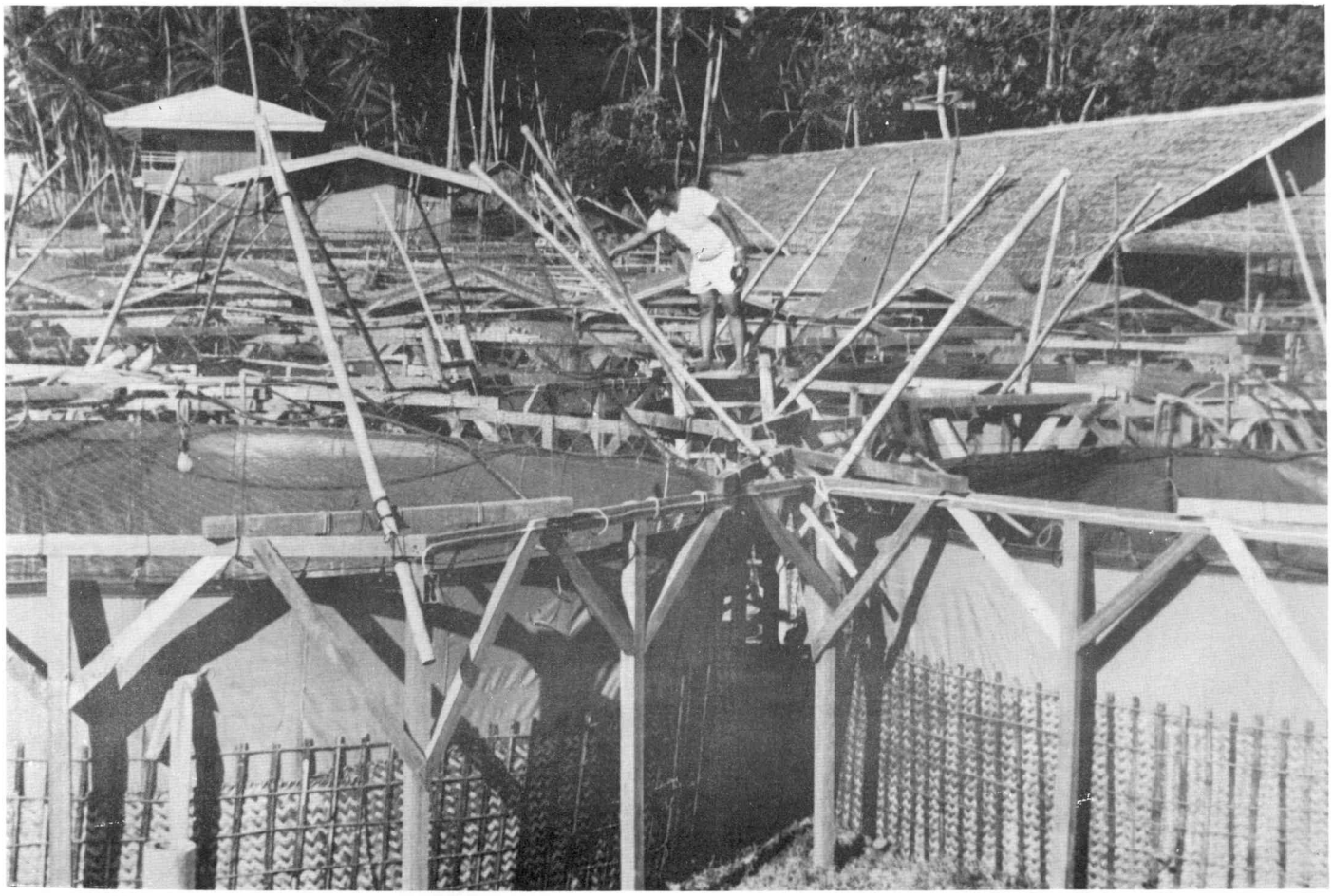
Two-bedroom staff houses and a nine-bedroom dormitory with kitchen, dining hall, and other amenities house researchers and workers. They have systems to gather seawater and freshwater. Electricity is provided by 50 generators run by gasoline engines, and transportation, by several small boats and land vehicles.

A one-hectare fishpen was also built near the laboratory building in a lagoon. Canvas tanks of various sizes have been pitched to hold the sabalo captive for experimentation, spawning and larval rearing, and also for culturing various planktonic feeds.

The station is actively involved in catching milkfish spawners with the aid of an otoshi-ami.



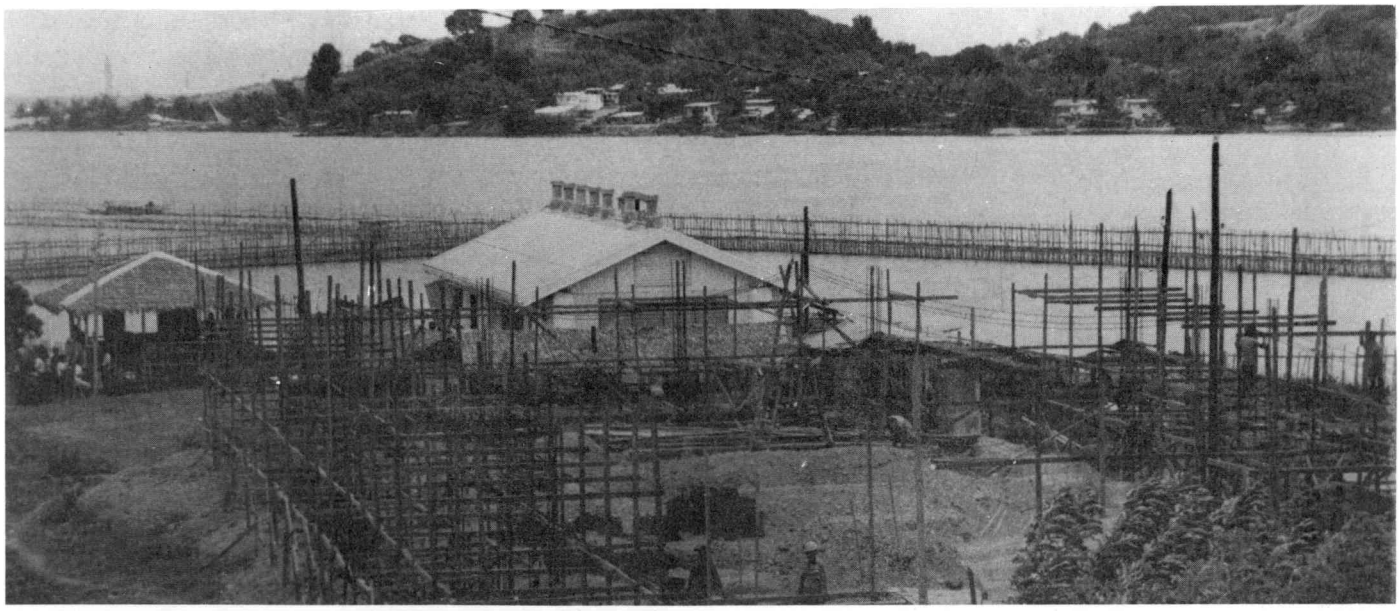
Copepod collector, Pandan Milkfish Research Station



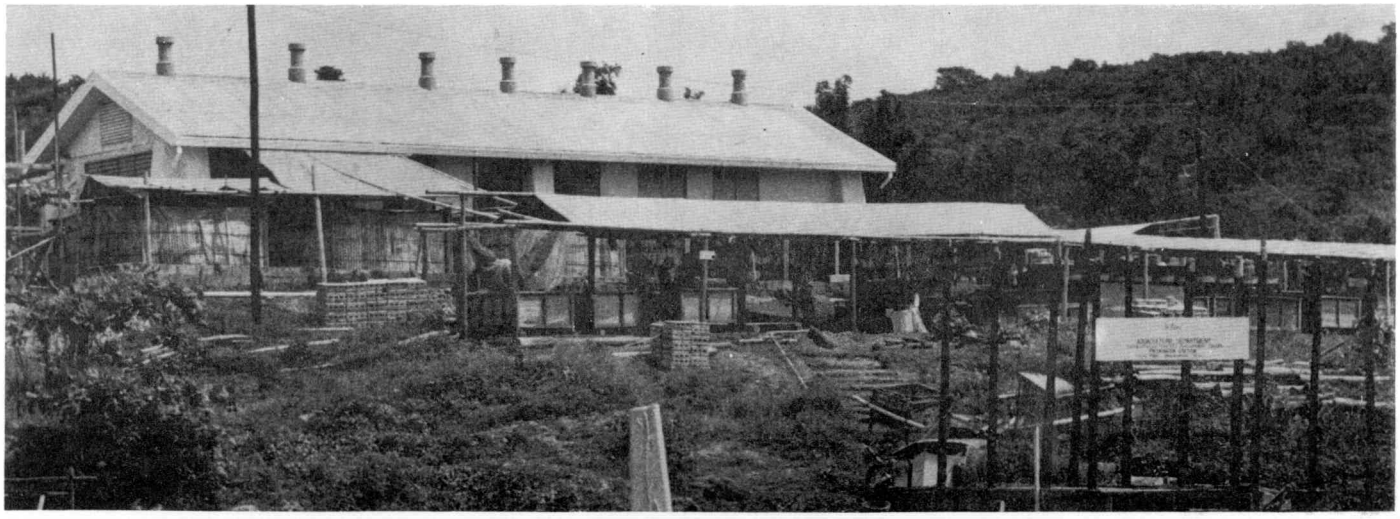
Sabalo spawning tanks, Pandan Milkfish Research Station

Freshwater Aquaculture Station

Located at a 45-hectare parcel of land in Binangonan, Rizal along the shores of Laguna de Bay, the site was selected for the following reasons: (a) The lake, a natural habitat of freshwater fishes, is fairly representative of other freshwater lakes in Southeast Asia. Techniques learned here can be taught to or adapted by other parts of the country, the rest of the Southeast Asian region as well as developing countries whose conditions are similar to the Philippines; (b) The project site is about an hour's drive from Manila, premier city of the country; (c) Its elevation prevents the rushing of flood waters, and allows the flow of water by gravity from a reservoir to different tanks and hatcheries; (d) It is strategically located and travel by water to and from the station is easy; (e) Hills at Talim and Pipindan protect it from monsoon rains and typhoons; (f) Some of the deepest waters of the lake are found around Tapao Point where limnological studies and other researches can be conducted under ideal conditions. (g) It is free from pollution with the Diablo Pass Channel guaranteeing a flowstream ideal for research.



The Hatchery Building under construction

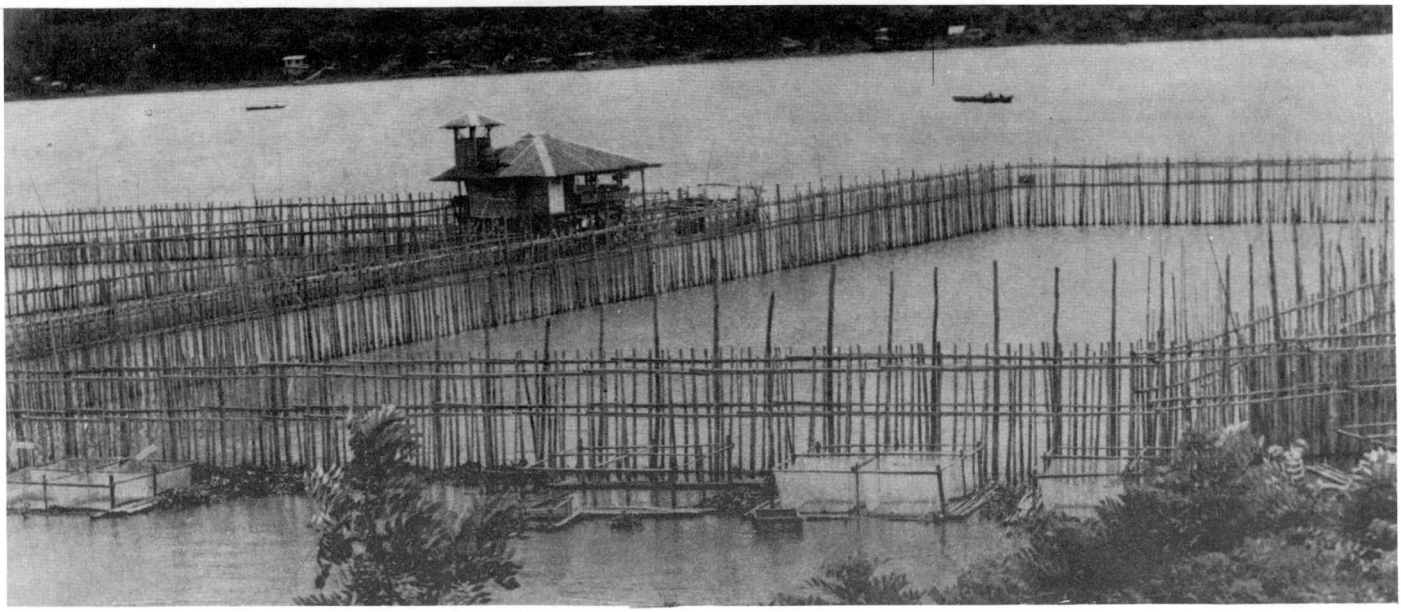


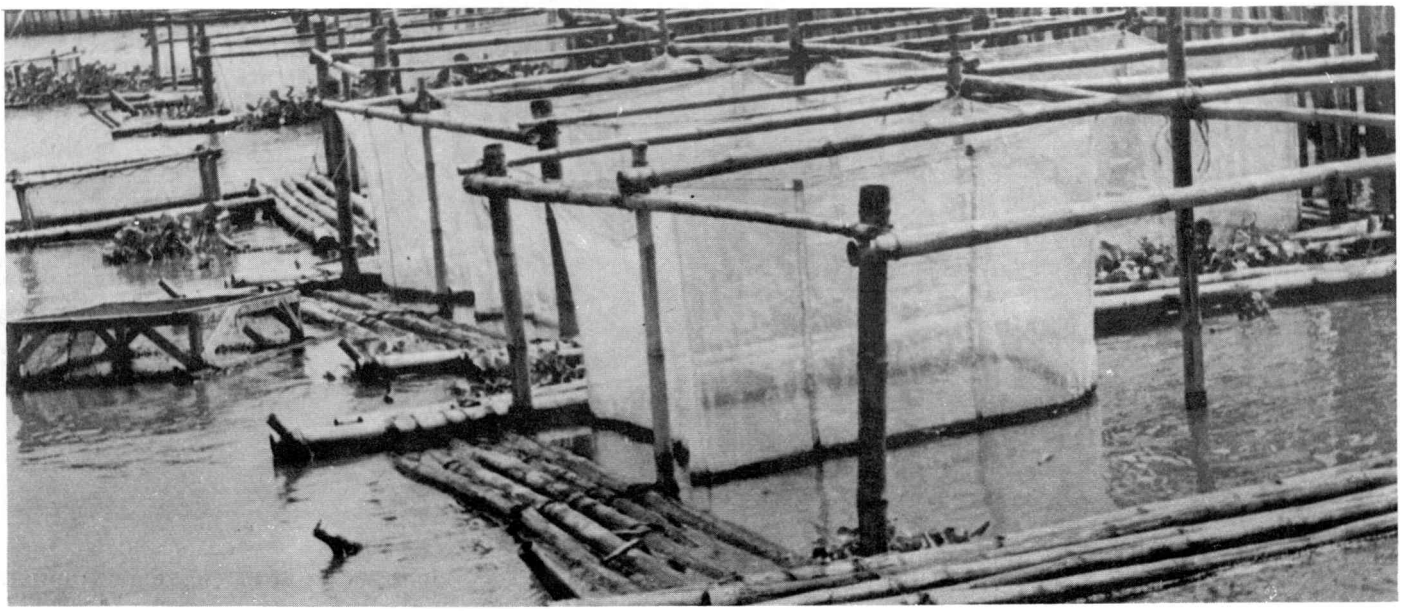
The Biology-Chemistry Laboratory and marine plywood tanks for mass production of postlarvae of M. rosenbergii

This freshwater project will complement our brackishwater stations in Panay Island. Pending issuance of a Presidential Proclamation reserving the area for SEAFDEC, the DNR authorized the agency to use four hectares initially for a laboratory and an administration building.

The Station started modestly but it soon expanded its research projects, prompting us to construct more buildings, acquire apparatus and equipment, and install new electric lines to serve the needs of the staff. A power station is planned to meet the demands for more electricity.

Infrastructure and buildings planned for construction include: road network, water system, power system and network, laboratories for chemistry, biology, feeds, etc., covered and open hatcheries, offices for researchers and administrative staff; library; lecture rooms with audio-visual facilities and with a capacity of 200 persons; five smaller class-rooms with a capacity of 40; cafeteria; family housing units; dormitories; physical plant; recreational facilities; experimental ponds; and pier.





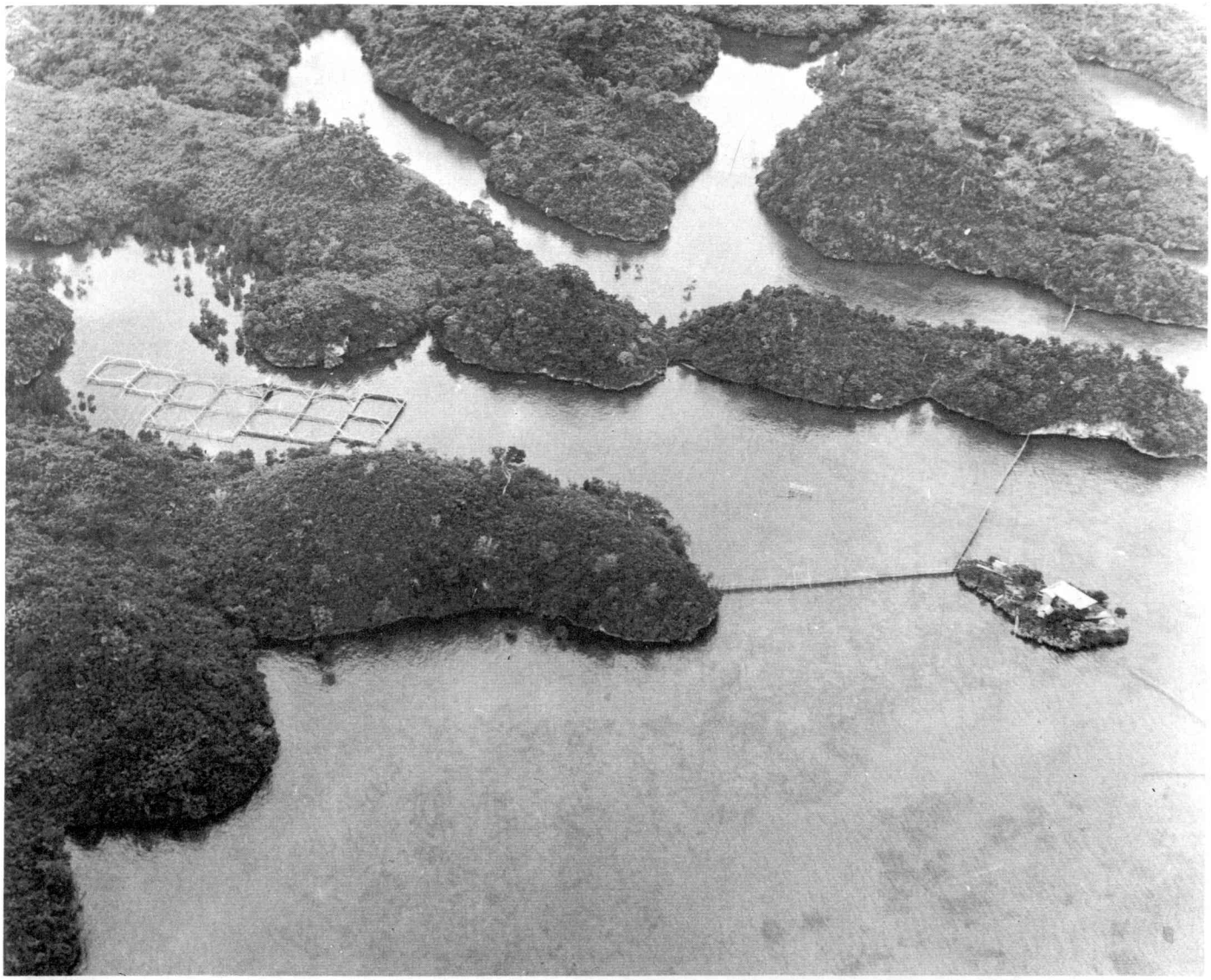
Floating cages for various experiments

Igang Seafarming Station

This station is situated in a marine area close to Igang Bay along the northwestern coast of Guimaras Island. The site covers 345 hectares, two-thirds of which are under water. It is about 12 nautical miles or 35 minutes by speed boat from the Tigbauan main station across Iloilo Strait. It is also accessible by ferry boat from Iloilo City and by land via the municipality of Jordan.

Tropical and oceanic conditions make the station suitable for seafarming research. It is sheltered from prevailing strong winds from the northeast or southwest. The water is typically marine and free from any agricultural or industrial pollution. Salinity ranges from 28-30 ppt, with surface temperature ranging from 27° to 29°C. Potable water for domestic and laboratory use can be obtained from wells. The tidal level ranges from 0 to 6.0 ft. The bottom soil is generally sandy and coraline; the inlets and coves have sandy and muddy bottoms. It has many coves of varying sizes which make it ideal for grow-out enclosures for commercial finfish and shellfish as well as for broodstock development. The 26 coraline islets include areas covered by mangroves, all suitable for ecological studies.

This seafarming station was initially used as a research site for the growth of the



Igang Sea Farming Station

P. monodon broodstock whose life cycle was completed recently. Gravid spawners from maturing females were collected from floating cages and hatched at our Tigbauan main station.

The facilities of this station include a two-room house made of nipa and bamboo with a laboratory at the basement, ten fixed pens made of bamboo and nylon nettings; a floating pen; one hired pumpboat, one electric generator with 1.25 kw., and other apparatus.

Experiments on the gonadal development of prawns, shrimps, milkfish and other aquatic species are conducted here. Cages and pens have been installed and a nearby cove is enclosed for broodstock.

Full development of this station is planned to start in 1977. Improvements will include a biochem laboratory building, wet and field laboratories, a training center, a dormitory-dining hall, two guest houses, six staff houses, generator and pump house including rootes blower house, two water tanks, an open pond for nursery, algae culture, rapid sand filter, cove enclosures, floating cages and fishpens, civil works, electrical distribution system and plumbing system with water, drainage, sewage and storm drainage.

Maturation pens and research laboratory, Igang Seafarming Station

Outreach Station, Zamboanga City

Our department's Mindanao seafarming task force has set up a temporary office at the city, but the construction of permanent facilities will start January 1977. These include: two shrimp and prawn hatcheries, two *macrobrachium* hatcheries, two nursery seed banks, finfish farms (2 units each) composed of mullet, rabbitfish, grouper/snapper, mussel/oyster, etc. This station will be a part of the main seafarming station in Igang, Guimaras Island.

The seafarming project in Zamboanga will consist of the following components:

1. The development of 150 hectares of atoll lagoon at Sta. Cruz islands to raise finfishes like siganids (dangit), mullets (banak) and milkfish (bangos) for demonstration, production and training. Around 25 hectares have already been developed. When funds become available, the entire lagoon will virtually be a reservoir of fish. In Zamboanga, there are about 10,000 hectares of atoll lagoon areas all of which are earmarked for development for the culture of viable finfishes.

2. The establishment of milkfish and prawn seed banks in Zamboanga City situated at the compound of the Zamboanga School of Fisheries, pending establishment of a prawn hatchery complex in the area. The fry for the seed banks will come from the hatcheries of the SEAFDEC Aquaculture Department in Tigbauan, Iloilo. The project will serve as the source of fry for those damaged by the giant earthquake last year.

3. The crab culture project which will demonstrate the mass scientific culture of crabs for the fishpond operators of the area. The project is planned to service family-size fishponds in Zamboanga and Cotabato. Only 2,000 sq. m. have been developed so far. As soon as funds become available, the mechanism to expand this to 100 hectares of intensive crab culture ponds will be implemented.

4. Development of mussel farms in Sangale and Rio Hondo. The Department, in cooperation with the BFAR, has set up growing rafts for mussels in the coves containing 500,000 breeder stocks for production and training purposes. The project will be expanded to develop 100 hectares of mussel farms.

Plans are underway to replicate similar projects in Jolo and Bongao.

Experimental mussel rafts

Students of the UP-SEAFDEC graduate program in Aquaculture.

PERSONNEL RECRUITMENT AND STAFF DEVELOPMENT

As of December 1976, we had a total of 473 employees of which 211 were in research; 17 with training and extension; and 245, as aides and technicians. According to station assignment, 337 or 72 per cent were in the main station; 32, in Leganes; 26, in Pandan; 8, in Igang, 10, in Binangonan; 24, in minor substations; and 36, in Makati.

Among those directly engaged in research work, 12 are PhD degree holders, 20 are MS holders, and 143 have BS degrees.

The Department expects to offset the imbalance of scientific personnel for aquaculture research in its local and foreign study grants. By the end of the Seven-Year Staff Development Program, the Aquaculture Department will have 52 PhD's, 60 MS graduates, and 83 BS degree holders. In addition to formal graduate work, SEAFDEC researchers are sent abroad for short-term observation studies on specific problem areas. In-service training courses are also conducted.

- **Local Study Grants**

Under our Staff Development Program, some promising employees were given scholarships to enable them to pursue graduate studies, effective the first semester of academic year 1976-77. The grants are renewable every year. Eleven pre-employment grantees are under the DNR-BFAR-SEAFDEC-PCARR Scholarship Program to study in the University of the Philippines System. Eight are majoring in Fisheries (Aquaculture), one in Marine Biology, one in Zoology, and one in Biology. Under the same program, eight SEAFDEC employees or Regular Staff Grantees are currently studying in the UP system. Three are majoring in Aquaculture, one in Marine Biology, two in Zoology, one in Biochemistry and only one is aspiring for a doctorate in Business Administration. The SEAFDEC Scholarship Program has awarded five grants to Regular Staff Grantees for 1976-77. Three are majoring in Environmental Science, one in Business Administration, and one in Development Communications.

The following staff members are recipients of study grants as of June 1976:

A. **DNR-BFAR-SEAFDEC-PCARR Scholarship Program**

(1) **Pre-Employment Grantees**

Mr. Gerald Quinitio
MS Fisheries (Aquaculture) U.P.

Ms. Rosario Alava
MS Fisheries (Aquaculture) U.P.

Ms. Catherine Torres
MS Fisheries (Aquaculture) U.P.

Ms. Veronica Alava
MS Fisheries (Aquaculture) U.P.

Ms. Isidra Bombeo
MS Fisheries (Aquaculture) U.P.

Ms. Nepheronia Jumalon
MS Fisheries (Aquaculture) U.P.

Mr. Jesse Banno
MS Fisheries (Aquaculture) U.P.

Mr. Adam Young
MS Marine Biology, U.P.

A SEAFDEC Researcher on an observation study on abalone culture, Kanagawa Fisheries Experimental Station, Japan

Ms. Jocelyn Lapidez
MS Zoology, UP
Ms. Corazon Simoy
MS Biology, UST

(2) Regular Staff Grantees

Mr. Florentino Apud
MS Fisheries (Aquaculture) U.P.
Mr. Dan Baliao
MS Fisheries (Aquaculture) U.P.
Mr. Miguel Ramon Calibjo
MS Fisheries (Aquaculture) U.P.
Mr. Demetrio Estenor
MS Fisheries (Aquaculture) U.P.
Ms. Elsie de Torres
MS Marine Biology, U.P.
Mr. Fermin Palisoc
MS Zoology, U.P.
Mr. Rodolfo Mateo
MS Zoology, U.P.
Mr. Relicardo Coloso
MS Bio-Chemistry, U.P.
Mr. Emmanuel Encarnacion
D Business Administration, U.P.

B. SEAFDEC Scholarship Program

(1) Regular Staff Grantees

Ms. Candelaria Casalmir
MS Environmental Science, U.P.
Ms. Teresa de Castro
MS Environmental Science, U.P.
Ms. Precilla Fallaeria
MS Environmental Science, U.P.
Mr. Alejandro V. Lim, Jr.
Master in Business Adm'n., U.P.
Ms. Charissa Marquiala
Master in Development Communications, UPLB

• Foreign Study Grants

The Department, in cooperation with international institutions, has awarded foreign study grants to members of its research staff. The grant covers full salary, living and installation allowances, tuition fees, clothing allowance, and supplies, thesis cost, research expenses, round-trip air fare, and a relocation allowance. Duration of the grant varies from one year to four years.

The following were given grants in 1976:

Alfredo Santiago
Reproductive Physiology
Auburn University,
Alabama, U.S.A.
Corazon Santiago
Fish Nutrition
Auburn University
Alabama, U.S.A.
Antonio Villaluz
Physiology
University of Guelph
Canada
Arthur Sanchez
Chemical Oceanography
University of Washington,
U.S.A.
Ronaldo Ferraris
Marine Biology
University of Hawaii
U.S.A.

• Seminars/Workshops/ Conferences

Our Department encourages members of the research as well as administrative staff to participate in any seminar, workshop, or conference that would upgrade their skills and expertise in local or foreign institutions. The following members of our research staff have availed themselves of this:

Mr. Leonardo Tiro, Jr, underwent a three-week training in mullet capture, handling and spawning at the Oceanic Foundation in Waimanalo, Hawaii; and a two-week observation study of fish culture techniques in Japan and Taiwan.

Mrs. Jurgenne Primavera attended the Eco-development Seminar in Tehran, Iran. The seminar was sponsored by the UN Environment Program and the Center for Endogenous Development Studies. She also took a two-week observation study tour of various aquaculture centers in Malaysia, Singapore, Thailand, and Taiwan.

Mr. Porfirio Manacop and Mr. Rolando Platon observed hatchery operations in various fisheries research institutions in Japan, Panama, Costa Rica, and Taiwan.

Dr. Felicitas P. Pascual went on an observation study tour of various fish feed and nutrition laboratories in the USA, Japan, and Taiwan immediately after attending the World Food Conference.

Architect Salvador Arcenas made an observation study tour of fisheries research centers in the USA, and Japan, to look into the design of an integrated Nutrition and Feeds Laboratory.

Mr. Ernesto R. Gonzales participated in a workshop on the Economics of Fishfarming (Aquaculture) at the EWC in Honolulu; and an observation study tour of several fisheries stations in Japan and Taiwan.

Mr. Einstein Laviña made an observation study tour of various mullet and milkfish research stations in Tahiti, Tonga, Fiji, and Hawaii.

Mr. Romulo Samson and Miss Pura Duldoco observed different fisheries research laboratories in Asia after attending a short-term training program on fish sperm and egg preservation in Bangkok.

Dr. William Vanstone and Mrs. Dorothy Ramsingh of the SEAFDEC-IDRC Milkfish Research Project observed fisheries laboratories and facilities in several South Pacific countries, including Taiwan and Singapore, in connection with milkfish culture and spawning.

Miss Virgilia P. Talaboc attended the Technical Workshop on Fisheries Statistics in Singapore from November 8-12, 1976. The workshop was sponsored by the SEAFDEC Marine Fisheries Department. **Dean D. K. Villaluz, Dean R.S. Ignacio, Mr. Pastor Torres,** and Dr. Benjamin Cariaso also attended the same conference

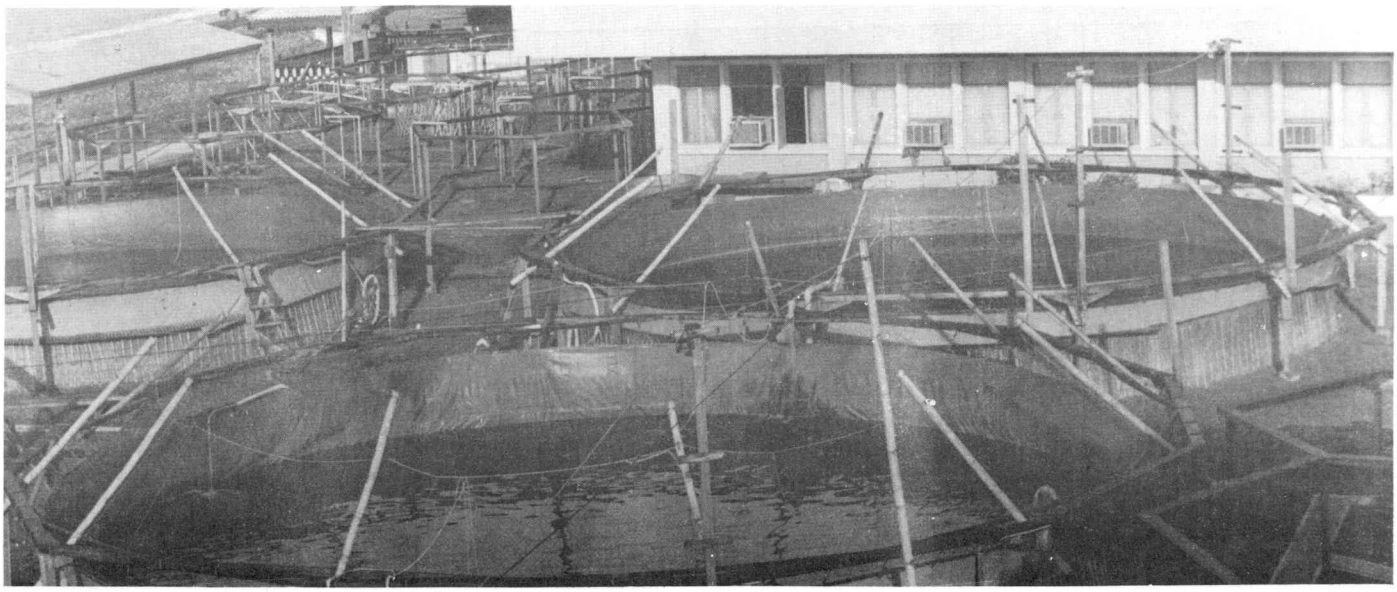
Dean Rufino S. Ignacio and Dr. Benjamin Cariaso also went to Colombo and attended the 17th Indo-Pacific Fisheries Council Conference from October 27 to November 5, 1976.

Dean D. K. Villaluz, Dr. T. Kawachi, Dr. Q. F. Miravite, Dr. H. Chaudhuri, Mr. P. Manacop, Dr. W. Vanstone, Mrs. Zenaida Balangue, Mrs. D. Villaluz, Mr. N. Hoshino, Mr. Y. Nukiyama, Mrs. D. Ramsingh and Mr. R. Platon attended the FAO Technical Conference on Aquaculture held in Kyoto from May 26 — June 2, 1976.

Dean D. K. Villaluz, Dr. Q. F. Miravite, Mr. P. R. Manacop and Mrs. Z. B. Balangue attended the Ninth SEAFDEC Council Meeting in Tokyo from December 6-10, 1976.

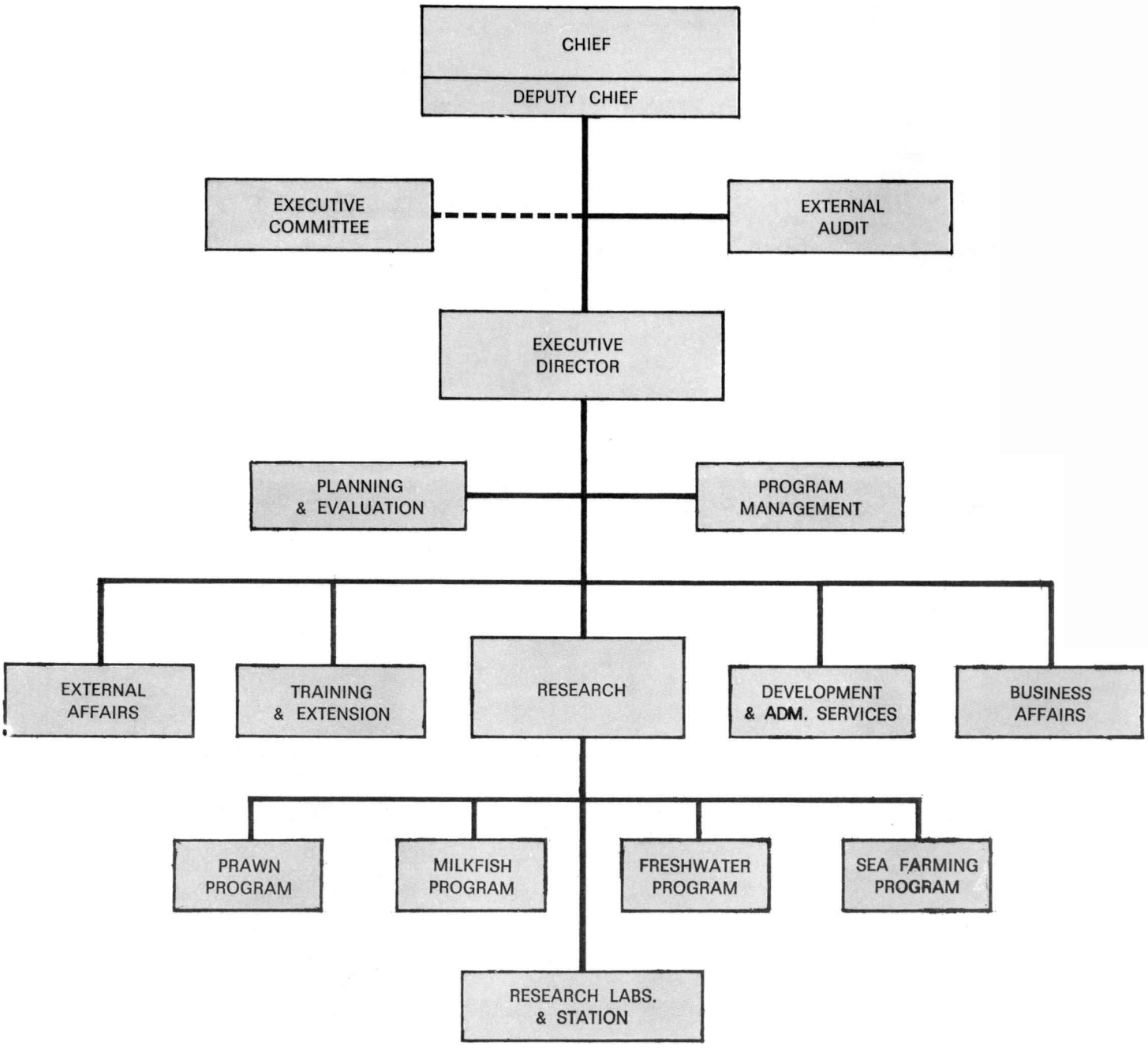
Local short-term training grants awarded to our administrative, development, and research staff members were mostly on management principles and procedures. A listing of the compendium of workshops and courses together with the names of those who participated follows:

NAME	COURSE
Zenaida B. Balangue	Budgeting and Financial Control
S. R. Tillo	Land Transportation
Rodolfo Dimafiles	PERT/CPM with Applications to Project and Operations Management
Jovenal Lazaga	Project Feasibility Study
Expedito Apol	Records and File Management
Soledad Mamiit	Records Management and Forms Design
Rey Constantino	Records and File Management
Natividad Millar	Supervisory Management Course
Renato Agbayani	Materials Management
Julie Ann Jaranilla	Materials Management
Ricardo Esguerra	Executive Development
Nicanor Primavera	Management by Objectives
Eleanor Guevara	Management by Objectives
Virginia Relampagos	Budgeting and Financial Control
Antonina Duremdes	Budgeting and Financial Control
Ma. Teresa Aguinaldo	Financial Management
Alexander Buenafe	Basic Management Program
Andreslto Degilla	Industrial Engineering



Sabalo domestication tanks in Tigbauan

ORGANIZATIONAL CHART



ADMINISTRATION

Extension of Department Chief's Term of Office

During the Ninth SEAFDEC Council Meeting in Tokyo last December 1976, the Council unanimously approved the nomination of Dean Domiciano K. Villaluz as Department Chief for another two years.

Reorganization of our Department

Our Department recently reorganized the management structure to meet the expanding research and development programs. This resulted in introducing decentralization which was expected to increase management's capability to implement our programs and related activities.

The highlights of the reorganization are:

- Chief and Deputy Chief

  Continue to function according to the duties and responsibilities stated in the SEAFDEC agreement.
- Executive Committee

  Is the chief policy making body of our Department. The Executive Committee also approves the funding and implementation of research proposals.
- Office of the Executive Director

  Exercises overall management and supervision in the planning and implementation of all our programs, projects and policies, particularly in relation to the Work Plan approved by the SEAFDEC Council of Directors.
- Five Major Divisions

1. Research Division

   Actualizes the planning and implementation of our research activities, management of research programs and coordination with other offices of our Department to insure the attainment of research objectives.
2. Training and Extension Division

   Handles training and extension programs in accordance with the Department's goals and objectives. It also coordinates closely with the Research Division regarding the transfer of technology from the researcher to end-user.
3. Development and Administrative Services

   Is responsible for the planning, implementation and management of the administrative and logistical support necessary to enhance the objectives of research programs and projects.
4. External Affairs Division

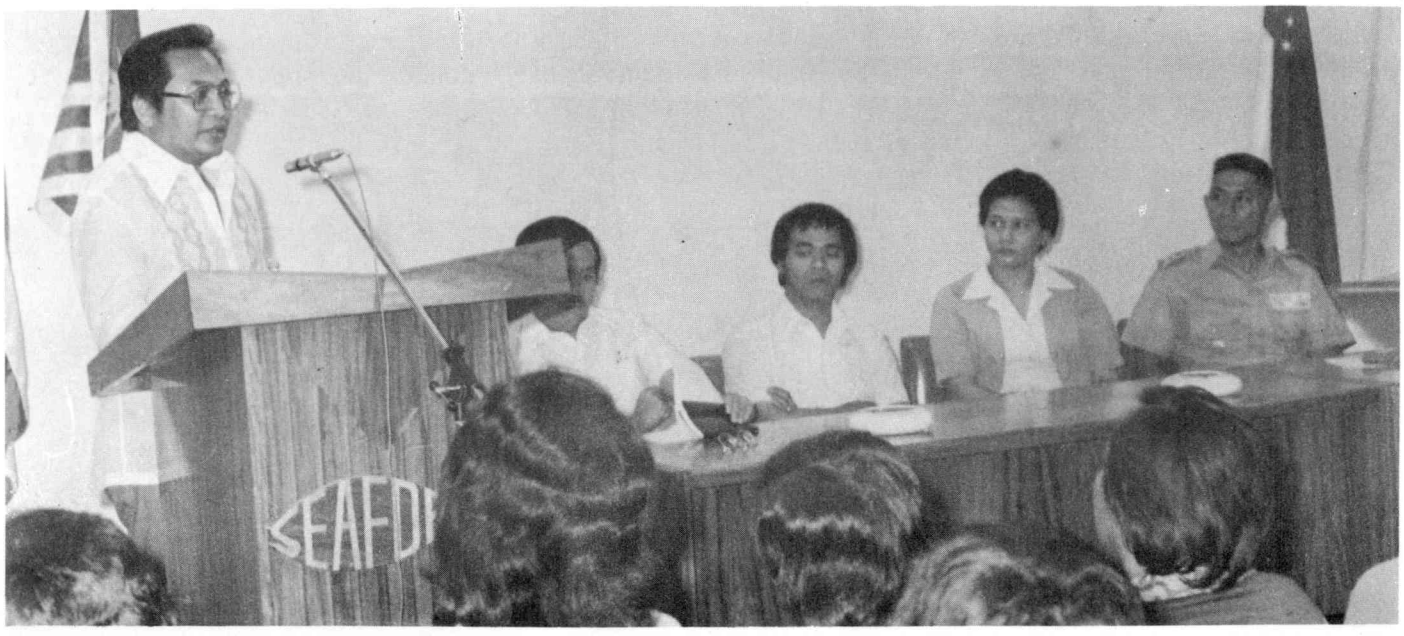
   Deals mainly with the development of linkages, both local and foreign, especially funding institutions, to provide adequate financial support for the Department's activities.
5. Business Affairs Division

   Takes charge of the management of all income generating activities of our Department to demonstrate the economic viability of projects particularly those related to aquaculture.

- Office of Planning and Evaluation

  Assists the top management in the preparation and evaluation of the performance of our programs.
- Program Management Staff

  Collates and analyzes data for top management decision making.



Atty. Garay, Director, Development and Administrative Services, during an inter-agency meeting in Tigbauan

Personnel
Key Appointments

Dr. Q. F. Miravite
Executive Director
Atty. Juanito M. Garay
Director, Development and Administrative Services
Dean Rufino S. Ignacio
Deputy Director, External Affairs
Engr. Pastor L. Torres, Jr.
Deputy Director, Development and Administrative Services
Mr. Porfirio R. Manacop
Deputy Director, Planning and Evaluation, Program Leader, Seafarming
Mr. Wilfredo G. Yap
Program Leader, Prawn
Dr. Jesus Juario
Program Leader, Milkfish
Mr. Eugenio Joaquin
Financial Officer
Mr. Marcelo Duran
Accountant
Mr. Renato Agbayani
Supply Officer
Ms. Julie Ann Jaranilla
Assistant Supply Officer
Mr. Ricardo Esguerra
Station Head, Leganes Station
Mr. Luis Rodriguez
Station Head, Igang Station

Creation of Various Committees

Our Department Chief ordered the creation of standing committees to ensure the effective operation of all the activities of our Department. Some of these committees are: Personnel, Technical Evaluation, Training, Development. A Seminar Committee was also created to organize regular and special seminars among our researchers with the help of local and foreign experts and resource persons.

A "Mindanao Seafarming Task Force" was organized to assist primarily in the rehabilitation of the calamity-stricken areas in Mindanao through the development of seafarming projects.

Personnel Benefits

We have implemented a provident fund plan for all our employees. Under the Plan, an employee contributes 10% of his basic salary and the Department contributes an equal counterpart, which is set aside for the trust fund. This fund, which will pay retirement benefits may be used for personal loans by any qualified employee. The Department also provides all employees with accident and life insurance coverage based on their salaries and respective positions. Employees and their immediate dependents are given free basic medical and dental services.

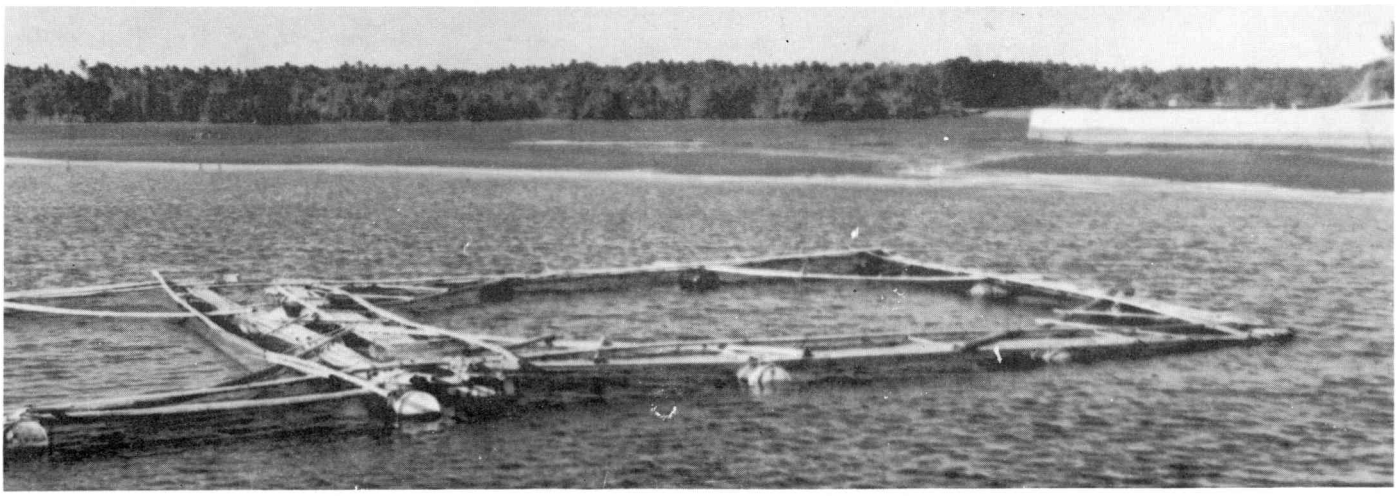
We established a promotions program for all employees based on performance rating and length of service. This resulted in the creation of new positions and adjustments in the salary scales.

Income Producing Units

We sorted out research and production activities at the Leganes Station. Products of the ponds will be a source of income for our Department.

Other income-generating activities will include the sale of prawn fry when the hatchery production techniques are perfected and the sale of bangos fry when artificial and/or controlled natural spawning is attained.

Auxiliary services like the cafeteria, dormitory, apartment and housing are also income-generating units. These facilities are under the supervision of the Business Affairs Division.



Lagoon at Pandan Milkfish Research Station

LINKAGES

Our functional linkages with various institutions here and abroad were placed on a firmer footing during the year. The Department receives funding support from international development agencies for specific research projects. It has made arrangements with other organizations for the exchange of technical information and expertise to step up aquaculture development around the world.

Linkages have been established with:

● **INTERNATIONAL**

South China Sea Fisheries Development and Coordinating Programme (SCSP)

We avail ourselves of the services of SCSP experts on short-term consultancies. In return, we extend our facilities to them under cooperative arrangements at their request.

East-West Center

We conduct a series of seminars and conferences on fisheries for participants from Southeast Asia and the U.S.A. together with the EWC.

Oceanic Institute (Hawaii)

We exchange information on mullet spawning with the Institute. We send selected staff members to the OI for short-term training on fish breeding. The OI also sends some of its experts to our main station to assist in the milkfish research project.

Pacific Biological Station

This station located at Nanaimo, British Columbia, provides us with men trained in tracking the movement of adult milkfish in coastal waters to determine their spawning areas. One of the methods used is ultrasonic tracking of milkfish.

Kuwait Institute of Scientific Research

An exchange of technical information on prawn culture between our Department and the KISR has been going on for some time. We send prawn fry specimens for experimental purposes to Kuwait.

Tungkang Marine Laboratory

We exchange information and expertise on milkfish and mullet culture techniques with this marine laboratory. As part of our staff development program, we regularly send researchers to participate in aquaculture projects in Taiwan.

Research and Design Institute for Danube Delta and Nucet Fisheries Research Center

We also collaborate with these two fisheries centers for the exchange of information and biological samples through the Government of Romania.

Agricultural Development Council (ADC)

A linkage with ADC has been established for seminars on mangrove swamps and other relevant topics.

National Oceanographic Data Center

Our working relationship with this information center started during the year. Our library received assurance of access to the services of the National Aquaculture Information System (NAIS) of the United States National Oceanographic Data Center.

Southeast Asian Regional Center for Graduate Studies and Research in Agriculture (SEARCA)

We collaborate with BFAR and SEARCA in implementing an integrated fisheries community development project (IFCDP) which seeks to transfer fisheries technology to fishing villages to enable the fishermen to have better lives. We also have working relationships with SEARCA's Agricultural Information Bank of Asia (AIBA).

Other Research Stations

We maintain close ties with research institutions like the Nagasaki University marine laboratory in Japan, the Interna-

Centre, Tokyo University of Fisheries, Japan International Cooperation Agency, and the Brackishwater Shrimp and Milkfish Culture Research Center in Indonesia.

● NATIONAL

Bureau of Fisheries and Aquatic Resources (BFAR)

The Philippine Government contributes funds to our Department through the BFAR whose Director also serves as the SEAFDEC Council Director for the Philippines. We have undertaken a number of projects with the Bureau, and we hope to intensify joint ventures with their staff in future projects, one of which is the seafarming program for Mindanao and Sulu.

Department of Natural Resources (DNR)

We also get funds from the Philippine Government through the DNR. With the establishment of a formal linkage with DNR, mutual consultations are made in the formalization of development programs for fisheries and aquatic resources.

University of the Philippines System (UPS)

Our graduate program was made possible through an institutional linkage with the UPS. SEAFDEC provides facilities and equipment while UPS handles the academic courses and awards the degrees. Our senior researchers are given joint appointments as faculty members.

Philippine Council for Agriculture and Resources Research (PCARR)

Our survey on the socio-economic aspects of aquaculture in the Philippines was completed in cooperation with PCARR's socio-economic research division. The Council also assists us in the formulation of programs in line with national priorities.

Mindanao State University (MSU)

We have re-established our institutional linkage with the MSU Institute of Fisheries Research and Development at Naawan, Misamis Oriental. An agreement is being worked out to harness fully the MSU hatcheries potential.

Central Luzon State University (CLSU)

The university's Freshwater Aquaculture Center in Muñoz, Nueva Ecija complements our Freshwater Aquaculture Station in Laguna de Bay.

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

A hydrometeorological station was set up through our linkage with PAGASA at our various stations to gather information on weather and climatic conditions in the area, and to assist in the monitoring and interpretation of weather data.

Food and Nutrition Research Institute (FNRI)

The FNRI provides assistance in the analysis of feed samples and other data related to fish nutrition and feed development.

Laguna Lake Development Authority (LLDA)

We have been conducting limnological studies of Laguna de Bay through the use of the LLDA's facilities, and in consultation with their experts.

National Pollution Control Commission (NPCC)

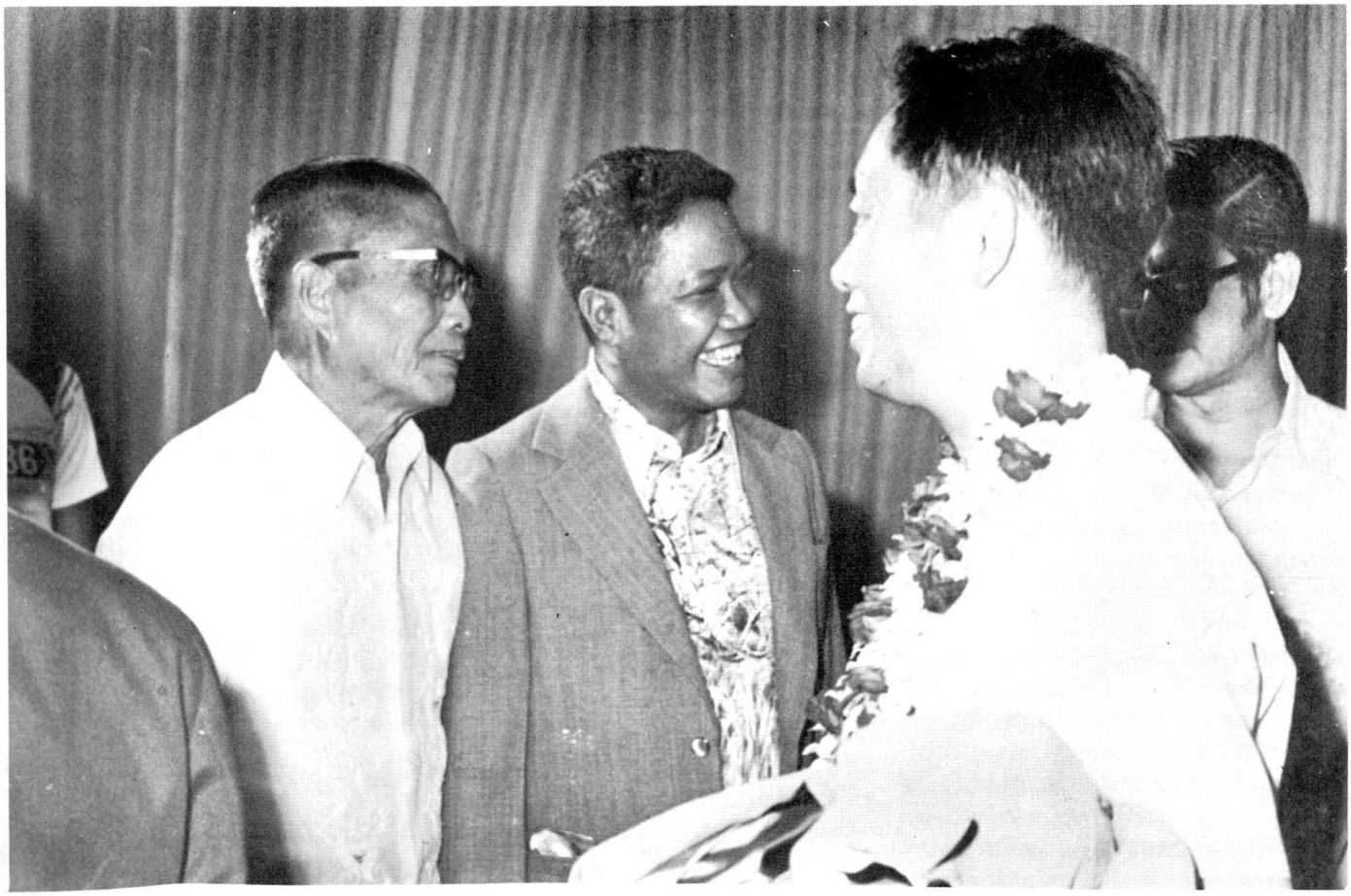
The NPCC assists us in the periodic monitoring of pollution indexes at our various project sites.

Armed Forces of the Philippines (AFP)

The construction of our Department's internal road system at its Tigbauan and Binangonan stations was undertaken by the 552nd Engineering Construction Battalion of the AFP.

FUNDING

As of December 1976, the total contribution of the Philippine Government in terms of buildings and facilities was US$9.7 million. Japan contributed a total of $2.7 million in the form of laboratory equipment, training grants, and services of experts. A number of funding institutions have also signified their interest in supporting our projects. The names of some of these institutions have been mentioned in the 1975 Annual report.



Dean D. K. Villaluz, Department Chief and Dr. Q. F. Miravite. Executive Director receiving Vietnamese visitors

Dr. Q. F. Miravite, Executive Director, Director Gonzales of BFAR, Admiral Iman Sardjono of Indonesia, and Mr. Domingo Tapiador of IPFC, Bangkok